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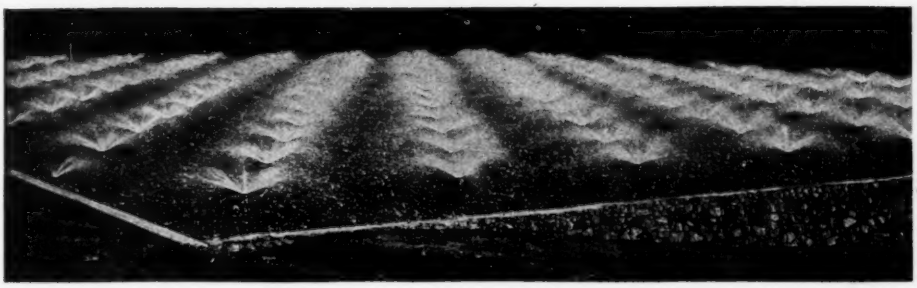

140 TAYLOR HEXAGONAL NOZZLES *at Chambersburg, Pa., operated by one 20-in. Miller Sewage Siphon.*

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In the editorial rooms of MUNICIPAL ENGINEERING *is a vast amount of data and information relating to every phase of city government, engineering and contracting, which has taken twenty-four years to collect. This information is at the disposal of the readers of* MUNICIPAL ENGINEERING *at any time they may desire it. If the subscribers of this magazine will write to us, specifying their wishes, we can supply them with valuable information that will greatly assist them in their work and investigations. No charge is made to subscribers for such service.*

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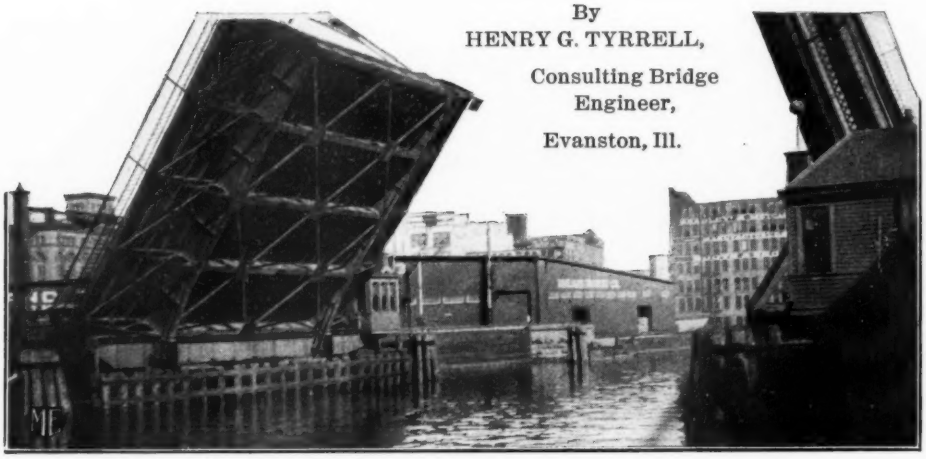
LIFT BRIDGES OF MILWAUKEE

By
HENRY G. TYRRELL,
Consulting Bridge Engineer,
Evanston, Ill.



BEST TYPE OF LIFT BRIDGE *in Milwaukee. A plate girder lift.*

MILWAUKEE is a leader in bridge building. Some of the first and best bascule bridges in America were erected there, and the types represented at Grand avenue and Broadway river crossings are in many respects still used as models for more recent ones elsewhere. The presence of the early bascule types at Holton, Huron and Sixteenth streets, while not so successful as later ones, show that the city was willing to experiment and pioneer in a branch of engineering which was then insufficiently understood in America.

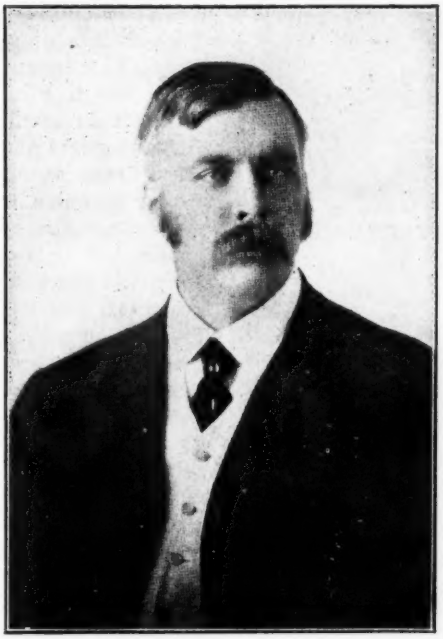
In order better to appreciate the importance of bridges in Milwaukee, reference must be made to the harbor and its shipping, which are of such great importance as to be one of the chief causes, if not the principal reason for the city's location and growth.

In recent years the volume of shipping has rapidly increased. The following figures show the amount of shipping in tons at four important lake ports, and its increase during the decade from 1897 to 1907.

	1897	1907
Milwaukee.	3,750,000 tons	7,696,000 tons
Chicago ...	10,643,900 tons	11,410,500 tons
Cleveland .	6,118,900 tons	12,247,600 tons
Duluth ...	4,776,000 tons	19,635,800 tons

It appears, therefore, that in ten years, the shipping at Milwaukee more than doubled, and is rapidly approaching that at Chicago, which has both branches of the Chicago river and the Calumet river in addition, the latter receiving a large amount of coal and ore.

The first three bascule bridges in Milwaukee were those at Holton, Sixteenth and Huron streets, built nearly twenty years ago. The Holton street bridge, built by the Milwaukee Bridge Company in 1894 from plans by Shailer and Schniglau is the only remaining bridge of its kind, the three similar ones at Chicago having been removed. It has a clear opening of 70 feet, with a deck 43 feet wide and 65 feet above water. It has several times been repaired and strengthened, but is still in use.



HENRY GRATTAN TYRRELL, *consulting bridge engineer, Evanston, Ill.*

The Sixteenth street viaduct, 4,000 feet long, over the Menominee valley, contains an opening span with double leaves, built by the Wisconsin Bridge Company in 1895, from designs by their engineer, J. Geist, but patented September 28, 1893, by Max G. Schinke, assistant city engineer. It is of the type invented in 1862 by C. T. Guthrie for military purposes in spans of 10 to 40 feet, and developed later by Lieutenant J. C. Ardagh. Its deck is 54 feet wide and 38 feet above water and when open the clear channel is 68 feet, tho the distance between pier centers is 88 feet. Each leaf weighs 65 tons, and they are latched under live loads. As the center of gravity of the whole mass moves back and forth in a horizontal line, the machinery is required to do no lifting, and it works easily, and opens in thirty seconds. The opening span cost $42,000. At the time of its construction George H. Benzenberg was city engineer.

The Huron street bridge, built in 1896 by the Milwaukee Bridge and Iron Company, was designed by Max G. Schinke, and patented by him in March, 1895. It has two leaves, each 46 feet long, and a 34-foot road with double outer walks. At each end are fixed approach spans of 87 and 42 feet. The river is 220 feet wide, but the channel is only 78 feet clear. Each leaf weighs 127 tons, including 50 tons of counterweight composed of pig iron and cement mortar. Each leaf can be opened by a 24-horse-power motor in 30 seconds. The centers of gravity of the leaves move in a horizontal line easily on roller bearings, which have several times been replaced. The floor consists of two layers of plank, and when the leaves are raised, the open space in the floor is large enough for a man or a horse to fall thru. It opens about twenty-five times per day, and cost $48,000. When inspected by the writer a year ago, the road was found to have no guard gates, and the pulling strut trunnions, which are above the floor adjoining the sidewalk, were running with oil, exposing pedestrians to injury.

A repetition of bridges such as those unsymmetrical ones carrying steam railways over the rivers on the south side, should be discouraged, for while they are interesting mechanical novelties and quite commodious, their presence adds nothing to the attractiveness of the district. A two-track wrought-iron swing span on the Chicago, Milwaukee and St. Paul Railway, over the Menominee river near the Union Station, was built from designs by Charles Shaler Smith in 1881. It was 216 feet long and turned by hand power. In 1886 it was replaced by another one 203 feet long on a skew of 63

GRAND AVENUE LIFT BRIDGE, *Milwaukee, Wis.*

degrees, with equal arms, and a channel opening of 50 feet. It was afterwards found that a channel width of 75 feet was required, and tho the old bridge was quite strong enough, it was replaced in 1904 by a new one with the pier out of center. The arm lengths are 133 and 49 feet, and the new span weighs 650 tons, not including 225 tons of concrete counterweight. Only a small height was available from rail to water, and the drum is therefore very shallow. In the year 1902 it was opened 9,000 times, oftener than any other bridge on the road. Another swing on the same road, over the Kinnickinnic river, two miles further south, likewise has unequal arms. It was completed four years ago.

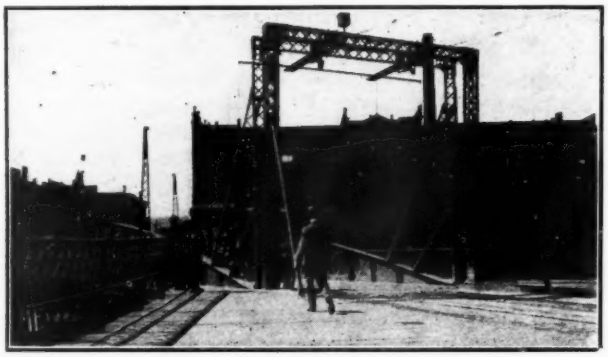
A single track swing bridge weighing 128 tons, was placed over the Kinnickinnic river in 1880 for the Chicago and Northwestern Railway. It was pin connected and 177 feet long, but in 1898 it was replaced by a double track structure 234 feet long, the old one being moved 200 feet down stream during the building of the new one. The turntable is a square box with corner girders, thus avoiding the expense of a circular drum, and making the pier diameter a minimum. Ten years later the same road moved its lattice bridge from Kinzie street in Chicago to Milwaukee, where it was re-erected over the Kinnickinnic river just east of Clinton street. Three extra panels were added to the north end, the weight of which was counterbalanced by material beneath the floor at the opposite end.

But by far the most interesting bridges in Milwaukee are the bascule spans, ten of which now cross the rivers at Grand avenue, Broadway, Muskego avenue, West Water street, First and Sixth avenues, Kinnickinnic avenue, East Water street, Michigan street and Oneida street.

The Grand avenue bridge was the first regular trunnion bridge in America. It has a clear distance of 95 feet between fenders, but as it crosses the river on an angle, the channel width is only 70 feet. It has tail pits and the arms have cantilever action when down. Its total cost was $85,000. The break in the floor was incorrectly placed, causing dirt from the roadway to slide down into the machinery pits.

The Broadway bridge, nearer the harbor mouth, is sometimes opened 150 times per day, and it is one of the busiest bridges in America. It has a 100-foot clear channel, with arms in the form of an arch when closed, and it cost complete $125,375. The Michigan street bridge bears the simple and appropriate tho unusual inscription on a metal plate, "built by the people of Milwaukee," a practice quite different to that of placing on the name plate the names of all the local aldermen who chance to be serving at the time of its construction.

The amount of power on the early bascule bridges was insufficient, and it has



OLD LIFT BRIDGE *at State and Martin Streets, Milwaukee, Wis.*

been about doubled on the later ones, that at Michigan street having a 50-horsepower motor on each leaf, and requiring 40 amperes to open it. Some further particulars of the modern bascule bridges are given in the following table.

A fine new bridge has been completed at Oneida street and one is soon to be placed at Buffalo street at a cost of $175,000. The old swing, which was built by a

Milwuakee Bascule Bridges

Street and Stream	Constructed	Clear Channel Ft.	Width, Ft.	Cost
Grand Avenue, Milwaukee	1902	70	64	$85,000
Broadway, Milwaukee	1903	100	60	125,375
Muskego, Menominee	1904	70	50	93,800
West Water, Menominee	1904	75	60	127,400
First Avenue, Menominee	1907	100		
Sixth Avenue, Menominee	1907	100		
Kinnickinnic, Kinnickinnic	1908		64	
East Water, Milwaukee	1909			
Michigan street, Milwaukee	1910		60	
Oneida Street, Milwaukee	1912			

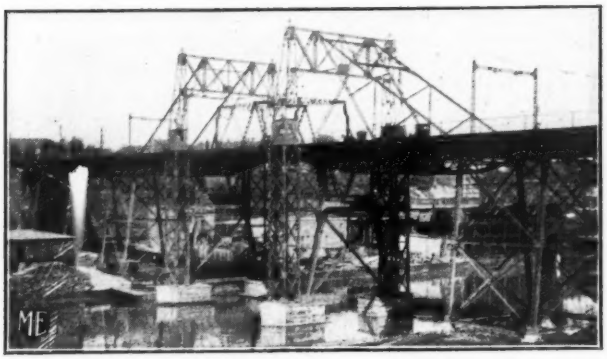
local company 38 years ago is very light, inadequate, and otherwise unsatisfactory.

Movable bridges usually show a greater lack of aesthetic treatment than almost any other form, and many of them are about as ugly as could be imagined, tho the modern ones in Milwaukee are about the finest of their kind yet produced in America. Like other bridges, their appearance depends chiefly on their outline, and their form should, as far as possible, show their purpose and action. If a wrong outline is chosen, no amount of after treatment can remedy the error.

As a general rule, each individual case will require different treatment. In cities like Chicago, London or Berlin, where the land adjoining the river is low, the bridge designs are perhaps more difficult to treat satisfactorily, and yet these cities, especially the last, have many examples of great merit. The height of the deck above the water greatly influences the design, and the required under-clearance may fix or determine the bottom outline. Deck bridges are nearly always preferable to thru ones, and should be used wherever enough height is obtainable beneath the floor for framing. In this respect the bascule bridges in Milwaukee are much superior to those in other cities, where thru trusses are used instead of plate girders, but plate girders are economical only for comparatively small channels. It should be noted, however, that the Tower bridge at London, with its clear opening of 200 feet, has plate girders beneath the moving leaves instead of trusses, tho the latter type are generally used in Chicago, where the river openings are only 140 feet. The reason for prefering deck bridges is evident, for parts above the floor obstruct the view, and may be a serious hindrance to travel, especially during crowded hours or in such emergencies as fire. When enough height is available, a curved form generally looks better than a straight one, tho the latter leaves more space for the passage of boats and river craft.

The design of bridges is also greatly influenced by the angle of the crossing, whether square or skewed, and by the approach grades. Double leaf bascules are the best form for decorative treatment, for the outline of the two leaves can be made symmetrical, and if the moving span forms a part of a long viaduct, such as those at First and Sixteenth streets, the bascule curves might be made to correspond with others in the adjoining spans. Single leaves are not artistic, for they lack symmetry. A combined bascule and cantilever, such as that patented by Mr. Newton, of Milwaukee, has a greater clear width between the piers, but the leaves, when raised, are unprotected, and none of this kind have yet been built.

A curved outline for the bottom chord,



HOLTON STREET LIFT BRIDGE, *Milwaukee, Wis.*

as on the Broadway bascule, usually looks well, and is suitable when the necessary height is obtainable, the form being used in 1839 for the Ouse river bridge at Selby, England, which has for half a century been the prototype for later ones. It is rather unfortunate that such designs as those at Stettin over the Oder, and at St. Petersburg over the Neva, have not been introduced in American cities, for they are not only commodious but are quite as attractive as any other beautiful city feature could be. Indeed they are much more prominent than beautiful park bridges, because of their location in the center of the city, where they can be seen by great multitudes daily.

Double leaf bascules are quite unsuited for railway service, as was proven prior to 1871, at Rhyl, where such a one was found to be a failure, because the center lock was insufficient to insure safe passage of locomotives from one leaf to the other. Notwithstanding this conclusion more than forty years ago, efforts have since been made to use double leaves for railway service, and two were installed in Chicago, tho the one at Campbell avenue was removed a year or two ago, for the same reason as that at Rhyl. Bascules such as the recent ones at Rotterdam and Duisburg, with two double leaf spans close together, would be applicable in Milwaukee, but all such adornment would of course add expense to the structures. The prize designs made in 1850 for a monumental bridge over the Rhine at Cologne, had a double bascule at the center, with imposing central towers connected with an overhead footbridge, similar to that on the Tower bridge at London.

A most fitting and suitable place for a beautiful or even monumental bascule bridge, would be at the State and Martin street crossing of the Milwaukee river. Such a structure would again single out Milwaukee as the pioneer in artistic bridge construction, as it already is a pioneer in its fine and commodious bascules, which, as far as mechanical operation are concerned, are nearly perfect. A combination of fine mechanical action, with architectural features, which might serve as memorial or monumental adjuncts, would be beautifully appropriate, especially in such close proximity to the city hall. And since the city is so prosperous commercially, and is rightly proud of its progress and achievements, it may well contribute a little extra appropriation for this bridge, in order to make it one of the show objects of the city. In addition to two car tracks the traffic is heavy and it is all crowded on a 16-foot roadway. Bonds for $150,000 for a new bridge have been voted.

Tourists who have returned from Europe, know very well how impressive are many of the fine bridges in the foreign capitals, or along the rivers of central Europe, such as the Seine and Rhine. They will remember the bridges of Dusseldorf, Worms, Mainz, Cologne, Paris and Berlin, after many other objects have been forgotten. Even at London, with many persons, the bridges over the Thames are of greater interest than

the beautiful or historic buildings along its banks. And in proposing a fine monumental bascule bridge for Milwaukee, the same interest would develop here, so that the Cream City, which is already a convention favorite, would be all the more attractive.

An impression has long prevailed that bridge design consists only in the mechanical developments, the computation of stresses and the proportioning of parts thereto. This is quite a mistaken notion. It would be just as near the truth to say that the design of the beautiful city hall, post office or library, consisted in the mechanical equipment of elevators, heating and lighting arrangements. These are quite necessary adjuncts to a fine and commodious building, but no one would think of entrusting the whole design to a draftsman capable only of developing such mechanical ideas. Yet the design of bridges is often left to be developed by the factory, with the result that too many bridges have no other indication than a purely factory made product, with about as much aesthetic merit as the ordinary structural iron work which goes into buildings before it is covered in or enclosed from view. The productions of bridge builders in the first half of the last century are vastly superior, as far as aesthetic treatment is concerned, to the work of the last fifty years, when spans of great length have been completed in ungainly lines and uncouth proportions. It remains therefore for the progressive men of the twentieth century to return to the aesthetic standards of a century ago, and the time has now come when American cities should insist upon a higher character of bridge design, based upon the combined requirements of economic proportion and aesthetic appearance.

ROLLING LIFT BRIDGE *at Huron St., Milwaukee, Wis.*

LOS ANGELES ALDERMAN PROPOSES MUNICIPAL BIDDING ON PAVING CONTRACTS

Councilman Charles McKenzie has worked out a plan whereby the city of Los Angeles will become a prospective bidder on all paving contracts, and it is believed that it will save the property owners much money.

This plan which Councilman McKenzie has been working on for several months will do away with the present wide range of bids for exactly the same class of work in different parts of the city. He is determined that the only way that the property owners can obtain uniformly low bids on paving contracts is for the city to bid on as many contracts as it can spare money enough to carry on at one time.

In this way the contractors bidding on all street paving work will face the contingency of the city bidding on all jobs which they seek, and they will be prevented from getting together and agreeing among themselves that one shall have this contract and another take that, with the result that there is no real competition for any of the jobs, and the successful contractor gets the job practically at his own price.

The city will have to organize a street construction gang, entirely apart from the present force. It is suggested that they take as much of the aqueduct equipment as is needed and pay the aqueduct department. By so doing, teams, tools and equipment can be had at much below the cost of new equipment.

The least amount that will be necessary to start this fund for doing paving will be $2,500,000.

CONCRETE PAVEMENT CONSTRUCTION

By the Morse-Warren Engineering Co., Carlinville, Ill.

IN a previous article, the authors of the following paper discussed some "Concrete Pavement Failures," showing a need for radical changes in the methods of design and construction at present prevailing generally thruout the country. In the present article will be presented as clearly as may be a rational and definite system of design to be used as a guide in determining a correct thickness of the pavement slab, consistent with its width and strength. Headings are also included bearing on other features of construction which are most frequently neglected in pavement work.

CONCRETE ROAD *in Winona County, Minnesota. Gravel shoulders had not been put in when this photograph was taken.*

The subject will be considered under headings as follows:

Pavement Section

The methods of design here outlined are intended to provide a pavement able to sustain the traffic of cities having from five to fifty thousand inhabitants, and for successful use on country highways. The design includes the determination of the most economical shape of cross-section and the proper thickness required to resist the forces tending to rupture it.

The forces tending to crack a concrete pavement longitudinally are:

(1) Freezing and thawing.

The action of frost in the ground at the edges of a concrete pavement will create a force sufficient to raise and lower the sides of the pavement.

(2) Swelling and shrinking.

It is a very common sight to see large cracks in the natural ground, due to horizontal shrinkage during dry weather, and a fact equally well shown is that earth swells on taking up moisture. This swelling and shrinking of the earth has a vertical force sufficient to raise a pavement slab, and unless the slab is of proper thickness and strength a failure may be expected.

Observations have been made which confirm this conclusion and at the present time the writers and others are conducting careful tests to determine more definitely the amount of this vertical motion. It is certain that as much as ⅜ of an inch of vertical motion must be provided for.

(3) Settlement of sides of earth fill.

The settlement of the sides of an earth fill may exceed that at the center, where usually it is more compacted, by 5 per cent. and may amount to one inch, causing a cantilever action by depressing the sides. Even on the foundation of an old dirt road the sides are less compact and dense than the center.

Therefore the pavement may be cracked by bending moments caused by upward pressure near the sides or by the settlement of the ground below the sides. The flexibility of a concrete slab is not sufficient to allow of its conforming to these unequal movements in the foundation. The fact that miles of concrete

pavements today have cracked longitudinally is sufficient proof that a proper design was not used. The pavement slab must be designed to sustain itself under these forces and the assumed load of traffic. Some of these forces will unquestionably act on every pavement and unless the pavement slab is designed as a beam, it may be expected that longitudinal cracks will develop.

The forces tending to crack a concrete pavement transversely are:

First. Shrinkage of the concrete when curing without an abundant supply of water. This is probably the most frequent cause of failure transversely. The amount of shrinkage depends largely on the richness of the concrete used and the amount of water furnished during the first weeks. Judging from tests of Considere and others an amount of 0.05 per cent. for a 1-2-4 mixture and 0.1 per cent. for a 1-1-2 mixture is nearly what may be expected. For a block 50 feet in length this is nearly equivalent to a shrinkage of from ¼ to ½ inch and is about as much as the contraction caused by 100 degrees of change of temperature.

Second. The expansion and contraction due to changes of heat and moisture in the concrete. Contraction from these causes tends to slide the slab on the foundation generating tensile forces which frequently rupture the slab transversely, and diagonally as well when occurring in conjunction with cross bending moments.

The method of determining the proper thickness of slab in any case is outlined below:

It is assumed in the discussion that the centroid of application of these vertical forces will be one-third the distance from the edge to the center of slab, so that the actual beam considered will be two-thirds the width of the pavement. Letting h=thickness of pavement, l= length of beam considered, w =live load per square foot, and R=modulus of rupture of concrete, the formula for thickness of a plain beam with no factor of safety allowed resolves to the form,

$$(1)\quad h^2 - 0.065\,\frac{l^2}{R}\,h = \frac{w}{192}\cdot\frac{l^2}{R}$$

From which, in any case at hand, having the width of pavement, strength of concrete and assumed live load, the required depth may be obtained, to which should be added as much as 1 inch, as a factor of safety.

Two widths of pavement are herein considered by formula (1). For 9 feet in width, a live load of 200 pounds per square foot is assumed, and for 18 feet, 100 pounds per square foot. With usual moduli of rupture and a 1-1-2 mixture, the thickness required for 9 feet is 5.0 inches, and for 18 feet, 7.8 inches. And for a 1-2½-5 mixture, the thickness required for 9 feet is 5.9 inches, and for 18 feet, 9.6 inches. It will be observed that the requirements here presented necessitate a much stronger and more costly pavement than has heretofore generally been constructed, and which will, if engineers continue to build the present extreme widths of slab, increase the cost of concrete pavements to that of the standard pavements of today. Fortunately costs may be safely and greatly reduced by the use of properly constructed longitudinal joints, reducing the width of slab. Take for comparison two 9-foot and one 18-foot sections. At a cost of 15 cents per inch of thickness per square yard of area, there is a saving of 50 cents per square yard by the use of two sections 9 feet wide, with a properly constructed separation joint in the center of the roadway, the edges of the joint to be protected by a metal plate developed for that purpose. This saving amounts to about $5,000.00 per mile. Therefore in constructing a concrete pavement which exceeds 12 feet in width, it is not economical to build it in one section.

Proportions

The hardest and strongest wearing surface which can be made with Portland cement concrete is still much softer and less durable than the average brick pavement surface. From observation and tests the writers believe that the best concrete surface will wear away about five times as rapidly as brick. Hence the hardest surface that can be obtained is none too good.

The proportions of the several materials composing the concrete govern largely the strength of the body and the hardness of the wearing surface. The proportions in the body must be such as will give the strength required at the least cost. Having obtained enough strength in the body, the primary consideration must be, the construction of the hardest wearing surface possible; this is demanded by the abrasion and shock of modern traffic.

A comparison of many tests indicates that the 1-1-2 concrete possesses about 20 per cent. more strength and hardness than a mix of 1-1½-3. It therefore becomes evident that something extra must be spent to obtain the greatest durability. A pavement built entirely of 1-1-2 will cost, for concrete work, 8 per cent. more than one of 1-1½-3, but its life will be at least 20 per cent. and probably 40 per cent. greater. For when the strength of any material is overtaxed, it fails with increasing rapidity.

Should an engineer hesitate to choose a mixture of 1-1-2 concrete, having a section so thin as will provide the necessary strength, the other rational course is open to him of choosing two-course work making the body of 1-2½-5; and the top coat of 1-1-2, which will give all the advantages to be secured by a perfect concrete pavement at somewhat less cost than a one-course 1-1-2 mix. In two-course work, there is some chance to be taken of not securing a perfect bond unless the inspection is right. The writers have however seen some perfect pavements constructed in this way, and over the country, the pavements which appear to be giving the best satisfaction are two-course jobs. The several advantages of two-course work may be enumerated as follows: 1st. The ability to use the entire strength of the cement in the rich coat, whereas, if rich one-course work is employed a large per cent. of the cement may run to the sides or bottom of the slab, thereby giving a less rich mixture for the wearing surface. Second. The necessity of providing only a small amount of the most durable and most costly stone, which may prove to be uneconomical for the entire body in many localities. Third. By specifying two-course work more emphasis is placed on the importance of durability in the wearing surface, and whereas a contractor might neglect or consider too expensive the screening of all his materials in a one-course job, the screening for the top course in two-course work, where necessary, can hardly be objected to.

A possible objection to two-course work lies in the fact that shrinkage from drying amounts to much more in a rich mixture than in a lean one, which will tend to cause hair cracks to develop in the surface. These are frequently observed in cement walks. It is observed, however, that they do not appear in walks having a top as thick as 1 inch, and with a 2-inch coat these forces will adjust themselves without causing rupture.

The advantage of one-course work lies in the simplicity of its construction. Its cost is somewhat greater than two-course work for an equal hardness of wearing surface. It has been popular for the reason that a fairly good second class job can be secured at rather smaller cost.

It is believed, however, that first class concrete pavements can be built by both methods, and these specifications will cover both.

Preparing Foundations

The first consideration is drainage. This has been in the past frequently secured by French drains of crushed stone placed below the edge of pavement. The modern method of securing drainage is by laying of a vitrified field tile along the outside and distant from the edge of pavement about 1 foot and to a depth of from 15 to 30 inches, carried to a proper outlet at the first culvert. A 4-inch tile is of ample size and the cost is as follows:

Tile delivered on the work, lin. ft.	$0.025
Laying and backfilling	0.025
2 per cent. added for outlet	0.001
Total per lin. foot	$0.051

This provides a permanent, and perfect drain at a cost of not more than 5 per cent. above old time modes.

Some effective means of drainage must be employed in building a concrete pave-

ment, as it is very desirable to keep the foundation stable and avoid as much vertical movement as possible.

After the rough grading is accomplished by the use of teams or tractor, the engineer should provide finishing stakes as close as 25 feet, which allow the use of string and template in completing the subgrade. The surface of subgrade should be finished so as not to vary at any point ½ inch from its intended position after the rolling is completed. A steam roller should be used weighing from eight to ten tons. If such can not be obtained good results may be secured by the use of traction engine. All spongy spots developed in rolling must be excavated and refilled with firm material.

CONCRETE Y *on State rural highway in Winona County, Minnesota.*

It is imperative that the foundation of the pavement shall be evenly and uniformly compacted.

Quality of Materials

The quality of the materials used, together with their proportions, determine the strength and durability of the concrete to a large extent.

The sand used must be free from soft particles of stone, earth, or vegetable matter. For the body course it may run uniformly in size from ⅜-inch down to fine finishing sand, while for the top coat it should grade from ⅛-inch down.

The stone used in the body should be crushed stone of the greatest hardness and strength which can be economically obtained. For the top coat the stone must be the hardest obtainable. Crushed quartz, trap rock, or granite must be secured to give the most durable wearing surface, and, where the amount required is small per square yard, the cost per cubic yard should not be spared. Economy should play a very small part in the construction of the wearing surface of a concrete pavement. When the stone and sand are properly chosen and graded, a dense, durable concrete is obtained. The use of bank run gravel is bad practice. In fact, there is very little gravel found which has a quality good enough for use in any part of a concrete pavement.

A great difference exists in the strength and soundness of various brands of cement. The fine grinding which some mills have adopted in recent years, allows the strength of lean mortars to run to much larger figures than were common two or three years ago. The writers have tested brands the past year some of which show on a 28-day test a tensile strength of about 600 pounds and some give a test up to 800 pounds. Many tests of neat cement strength run up to 900 pounds per square inch. In a concrete pavement where the hardest surface and greatest strength

of body is essential, a high standard of cement should be required. The expense incurred in obtaining an abundance of the best of other materials should not be discounted by the use of weak cement.

The specifications for cement adopted by the American Society for Testing Materials should be used except that thirty days shall be allowed for inspection and tests from the time of delivery to the engineer of samples, which shall be delivered within ten days from the day of award. And further, that the neat cement 28-day test shall equal 700 pounds per square inch and the one part cement, three parts standard Ottawa sand, 28-day test, shall equal 300 pounds per square inch. These specifications will include fully two-thirds the standard brands of cement and will insure the taxpayers a chance for a job of first quality.

Screening

All sand used shall be screened to secure the correct grade of size and to remove all dirt, soft stone and debris. All stone or gravel delivered which shows clods of earth, coal or foreign matter must be screened. No matter how strong and sound the cement or how rich the mixture, unless they are delivered into the mixer absolutely clean and free from foreign matter, the pavement will be sure to show pit holes and weak spots, which will start ravel and wear. To assist in keeping stone clean and facilitate shoveling, it must be piled on 2 inches of sand. This item has been found very important in keeping clods from the base out of the mixer.

Expansion and Separation Joints

Experience gained during the past years has demonstrated that transverse expansion joints should be placed from 25 to 50 feet apart, depending somewhat on the thickness of the pavement slab and on the condition of the foundation.

While engineers are fairly well agreed as to the proper spacing of expansion joints, they are greatly in doubt as to their proper protection.

The following specifications for the protection of expansion joints are believed to be the most complete and adequate yet devised and are herewith submitted. "Expansion joints shall be protected by a T-shaped soft metal bar, having the head thereof spanning the space between the sections, and the stem interposed between the confronting edges of such sections, and compressible strips disposed at the opposite sides of said stem, said stem adjacent to its lower longitudinal edge being stamped out to form lugs spaced apart and designed to be embedded in the material of the sections."

Such a bar will absolutely protect the edges of the concrete sections and, instead of making the expansion joint in a concrete pavement the source of weakness, it will give it a strength equal to that of the other parts of the pavement.

All engineers have observed the unsightly and damaging cracks near the center of the street on concrete pavements. Such cracks are not only unnecessary but very destructive to the life of the pavement, and yet they are seen on probably 95 per cent. of the pavements built today. By constructing a longitudinal separation joint in the center of the street and protecting it by a T-shaped soft metal bar, as above described for transverse joints, the damaging cracks will be absolutely eliminated.

Proper Mixing

The materials will be mixed in an approved batch mixer. Each batch will be turned over at least six times before being dumped from the machine. Every effort must be made to secure uniformity in each batch, the same amounts of water, stone and cement, lest an unevenness result in the quality of the wearing surface and strength of body. The attempt must be to secure a surface of equal durability. The mix will be made of jelly-like consistency, allowing a man to sink above his ankles, but yet not so wet that the water runs from the mass and leaves the stone deposited in one pile and the sand and cement elsewhere. Recent tests show that maximum strength is secured by using about three gallons of water to one sack of cement, in addition to a wet aggregate.

Placing the Material

Before placing the concrete, the foun-

dation will be thoroly sprinkled, which will prevent the earth absorbing the water needed to harden the concrete. The batch must be placed at once after mixing, and if two-course work, the bottom course will be wet enough, at the time of application of the wearing course, that a man will sink above his ankles, and the top course being of a like wetness, a perfect bond is secured. Both coursess are struck to the proper grade by an adjustable template. A bucket conveyor greatly simplifies this operation, both courses being mixed in the same mixer.

Finishing the Wearing Surface

A simple wooden float will be evenly applied at once to finish the surface. A float of flexible wood formed to truly fit the curve of the crown and extending entirely across the pavement will be allowed where carefully used. By this means much unevenness in the surface is avoided. No disturbance of the surface, after setting has begun, will be allowed, such as brooming or grooving, as it injures the texture and allows raveling to begin.

Surface Protection

As soon as built a wetted canvas will be spread over the surface to protect it from the sun, rain, winds, or frost. The canvas will remain until the surface has hardened enough to receive a covering of earth, which will be applied as soon as the canvas is removed. Concrete pavements are subjected more to the action of the elements than other classes of concrete work due to the large per cent. of body exposed.

Curing the Concrete

The pavement should be sprinkled twice daily, until water runs from all the surface. This should be continued for a period of ten days. Thirty days shall elapse from the day of construction of any section before it shall be opened to traffic. As a rule if the pavement can be brought thru its first 30 days in perfect uncracked condition, it is likely to continue good when of correct design. It is while in its weak condition that shrinkage from drying, contraction from cold, and action of the elements affect it most dangerously. By faithful sprinkling fully half the shrinkage from drying may be obviated. The rich top course is much more subject to shrinkage than the base.

It should be borne in mind that concrete requires a much longer time to cure in winter than in summer.

Inspection

The inspector of any pavement should be one selected, for his fitness, by the engineer. It is his duty to know that the foundation is true to grade, that the specified materials are mixed in the true proportions, in the right way, with proper wetness and laid with accurate thickness to grade. He must see that the surface is protected at once and sprinkled as specified. A daily progress report and force account must be kept. Without constant efficient inspection a successful concrete pavement can scarcely be built.

Workmanship

Nothing indicates more quickly than workmanship, the character of the job as a whole and nothing can give so certainly the stamp of high class to the job.

Conclusions

Conclusions from this article may be drawn as follows:

Economy requires that the width of slab shall not be greater than about 12 feet. When the pavement is wider than this, longitudinal separation joints shall be properly constructed.

The thickness of the section will be consistently kept in accord with its width and the strength of mixture adopted.

For this class work the hardest wearing surface possible to build will be required. A wearing surface having a weaker mixture than 1-1-2, cannot grade as first class.

It is desired to further emphasize the fact that it is impossible to build a successful concrete pavement except by the use of the best materials, the most careful workmanship and constant inspection. In fact it is a feat requiring engineering skill.

FILTRATION PLANT AT McKEESPORT, PA.

By E. C. Trax, Chemical Engineer in Charge..

SINCE 1881 the city of McKeesport has drawn its water supply from the Youghiogheny river at a point about a mile above the junction of the Youghiogheny and Monongahela. At the time of the construction of the original water works the river furnished a very acceptable source of supply. While no bacteriological records are in existence, it can be assumed that the water was not seriously contaminated with sewage, as the water shed was not thickly settled and sewer systems were less common in the smaller towns than they are today.

Industrial developments on the water shed have been very extensive, especially in the coal and coke industry, and there has been an attendant increase in the pollution of the water by sewage and trade wastes. In an attempt to secure better water a series of wells was driven along the river and a part of the supply drawn therefrom. The well water was much harder than the river water most of the time, and the bacterial content was also very high. It became evident that a new source of supply must be obtained or the existing supply purified. Mr. Alexander Potter was retained as consulting engineer and, after a thoro investigation by the engineer and the Board of Water Commissioners, it was finally decided to purify the Youghiogheny river water. On account of the high mineral content and acid condition of this water it was evident that filtration alone would not be sufficient to produce a satisfactory supply. Plans and specifications, including provisions for softening followed by filtration thru rapid sand filters, were prepared. After approval by the Board of Water Commissioners, these plans were submitted to councils January 14, 1907. As required by law, plans were also submitted to the State Department of Health for approval.

The River Water

The water in the river is unfit for use for several reasons. Altho generally clear it is at times highly turbid and constantly contains sewage pollution. Another condition is the high hardness of the water a large part of the time and the presence of free sulphuric acid and iron salts. The acid water is very corrosive in its action and the iron makes the water entirely unfit for laundry purposes even when perfectly clear.

The cause of the acid water is the pollution with mine drainage. The trade wastes from the various mills connected with the iron and steel industry are almost a negligible quantity. Sulphuric acid is ordinarily present in the waste water from coal mines and coal washers, being formed from the decomposition of iron pyrites by air and moisture into ferrous sulphate and sulphuric acid. Further oxidation of the ferrous sulphate may take place, resulting in the formation of oxide of iron, the brownish yellow coating on the beds of streams containing this so-called "sulphur water."

The country drained by the river is hilly and its fall is very rapid, so that it is subject to wide and sudden fluctuations in discharge. The heavy rains run off quickly, resulting in floods and low flow in dry weather. Immense amounts of acid mine water are discharged into the river and its tributaries; altho subject to some extent to seasonal variations the amount of this acid water is a fairly constant quantity. When considerable rain is falling over the water shed the mine drainage is more diluted, the acidity is reduced, and the water may even become alkaline for a few days, while during dry weather with a low stage of water in the river the acidity becomes very high. The first effect of a rise in the river is to increase the acid-

ity at McKeesport, caused by the storm water flushing out the pools in the ahead of the crest of the rise.

The longest period of alkaline water of which we have record is 11 days, from July 17 to 27, 1912, inclusive, while the longest period of acid water lasted 186 days, from June 23 to December 26, 1910. The yearly maximum and average acidity of the water since 1901 is tabulated below.

Year	Maximum	Average
1901	128	37
1902	204	36
1903	145	30
1904	162	48
1905	72	27
1906	106	23
1907	65	19
1908	240	63
1909	210	31
1910	390	81
1911	180	30
1912	140	30

The mean acidity from September 6, 1906, to September 6, 1907, was 22 parts per million, according to analyses made by the U. S. Geological Survey. It will be observed from the above table that the acidity during 1906 and 1907 is the lowest for any two years of which we have record.

The water in the river is extremely variable in its chemical and bacterial content. Chemical changes are going on constantly; the oxidation of the iron continues with the formation of greater amounts of free sulphuric acid which is more or less neutralized by the discharge into the river of small alkaline streams, increasing the sulphates of lime and magnesia. The processes of coagulation and sedimentation which are also taking place in the river all the time, altho on account of the rapid flow there is small opportunity for settling until the slack water at McKeesport is reached, and the germicidal action of the acid and iron salts, are responsible for the varying bacterial numbers in the river. The small number of bacteria and absence of B. coli during high acidity are the more remarkable because of the fact that sewage from a populous district is discharged into the river less than a mile above the water works intake. While the current is very sluggish here during low stage, due to slack water from the Monongahela river, this sewage must certainly be brought to the intake in the course of an hour.

During the past four years the total hardness has ranged from a minimum of 38 to a maximum of 804 parts per million, the acidity to phenolphthalein from 4 to 600 parts, and the reaction to methylorange from 60 parts alkaline to 390 parts acid. Some results illustrating the variability of the composition of the water are shown below in parts per million.

Date	Tot. Hard	Phenol. Read.	Methyl. Read.	Susp. Matt.
Oct. 30, 1910	804	—590	—390	None
Feb. 27, 1912	42	—5	+5	15
July 20, 1912	121	—4	+45	14,586

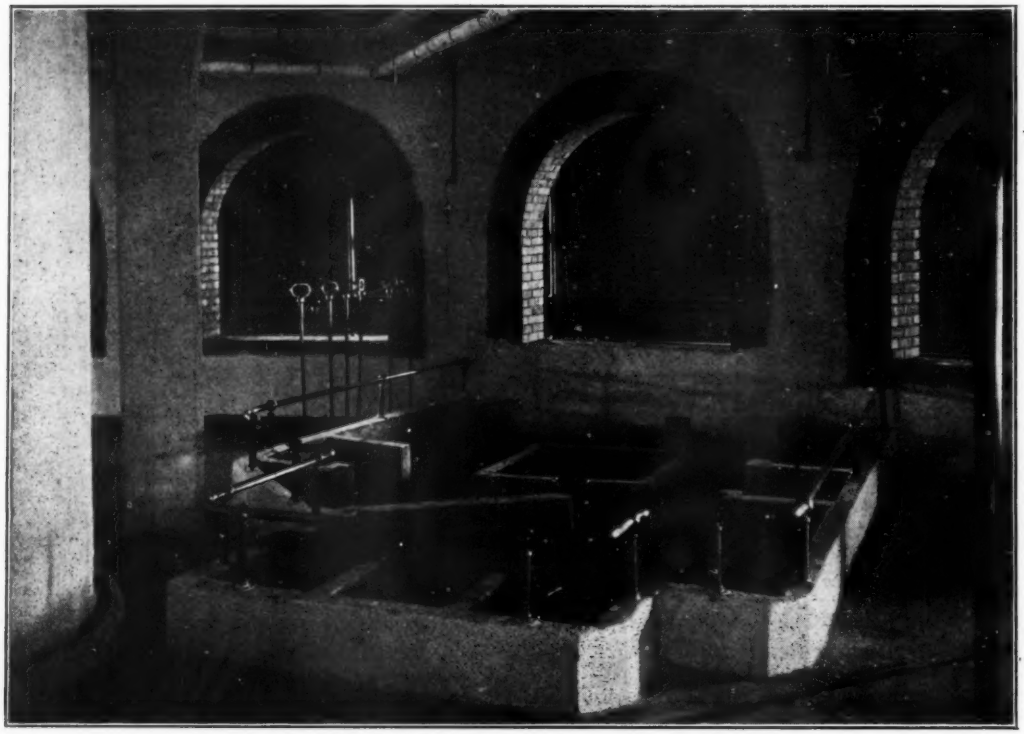
In the last mentioned instance the turbidity of the water was 16,000, yielding a coefficient of fineness of 0.91.

The variations are wide and sudden, frequent changes in hardness of 100 parts per million or more taking place within a few hours. In this connection the record of the daily tests for June 2, 1909, is submitted. Results are in parts per million.

Time.	Total Hardness.	Acidity to Phenolphthalein.	Acidity to Methylorange.
8 a. m.	118	90	45
11 a. m.	224	150	70
12 noon	430	300	160
1 p. m.	508	340	210
2 p. m.	440	230	140
3 p. m.	348	160	90
4 p. m.	300	110	40
6 p m.	173	80	35
7 p. m.	152	70	30
11 p. m.	116	65	40

It is thought that this acid wave was due to the dumping into the river of a quantity of partly spent acid by one of the mills above the water works intake.

The number of days the water has been acid, alkaline and neutral is shown in the following table:



FILTER ROOM, *Mckeesport water purification plant.*

Year	Alkaline (b)	Neutral	Acid (b)
1908 (Oct. 1 to Dec. 31)	0	0	92
1909	35	45	285
1910	15	5	345
1911	22	7	336
1912	46	2	318
Total	118	59	1376

(b) Acidity or alkalinity to methyl-orange.

At the end of 1907 it appeared that the acidity was gradually decreasing and that this condition of lessening acidity might be expected to continue as considerable areas of the coal on the water shed had been worked out and it was thought that the acid pollution was growing permanently less. The drainage from an old and abandoned mine, however, is usually more acid than that from an active working one, and subsequent records show that there is very little hope for better water in the river so long as mine water is permitted to enter the streams untreated.

The Purification Plant

In the latter part of the summer of 1908, long-continued dry weather with a low flow in the river, brought about a most severe acid condition of the water. The corrosive action of this fluid on the pumps, pipe system and plumbing fixtures caused a very serious state of affairs in the city; it became almost impossible to supply water and the leakage was enormous. A comparison of the pumping records for 1908 with corresponding months of other years indicates the extent of this leakage. The water softening and filtration plant was being rushed to completion at this time and an agreement was made with the contractor to begin treating the water at the earliest possible moment. The plant was

accordingly put into operation in an unfinished condition on October 11, 1908. The result was very gratifying to all concerned. The daily consumption of water was reduced during the first three months of operation from about 7,000,000 gallons to less than 4,000,000, and in place of a supply unfit for any domestic use, a clear, soft water suitable for every purpose was supplied. The cost of chemicals was, of course, very great, but this item was insignificant compared to the saving in plumbing, soap, etc. Even under such unfavorable and abnormal conditions the plant fully demonstrated that it was capable of performing the functions for which it was built.

Some data concerning the water softening and filtration plant:

Daily capacity of softening plant, 10,000,000 gallons.

Daily capacity of filter plant, 6,000,000 gallons.

Number of settling units, 4.

Capacity of each unit, 800,000 gallons.

Time of mixing at full capacity, one hour.

Number of filters, 6.

Area of each sand bed, 384 square feet.

Rate of filtration, 113,000,000 gallons per acre per day.

The Filtered Water.

The records show that since the softening and filtration operations were started, the city has been supplied with water of a uniformly high degree of purity. The water has always been remarkably clear and sparkling, free from color, turbidity, injurious substances or harmful bacteria, and has met in almost every respect the requirements of a first-class water supply.

Death rate from typhoid fever in the city of McKeesport:

Year	Death Rate Per 100,000 Pop.
1900	69
1901	81
1902	87
1903	120
1904	129
1905	63
1906 (c)	115
1907	73
1908 (d)	68
1909	18
1910	21
1911	14
1912	7

(c) Rate from 1906 to date includes residents of the city only.

(d) Filtered water first used in October, 1908.

While other sources of typhoid, such as milk supply, oysters, etc., must always be taken into consideration, it appears that much of the typhoid fever in McKeesport was due to the water supply, either the raw river water or contaminated well waters being responsible. Since purified water has been furnished many of the wells have gone out of use, and this has undoubtedly helped to reduce the prevalence of the disease.

The Lime Saturators

The lime saturator effluent is generally a clear solution of sufficiently uniform composition. This solution is tested several times each day and the lime charged into the saturators regulated accordingly.

The Settling Basins

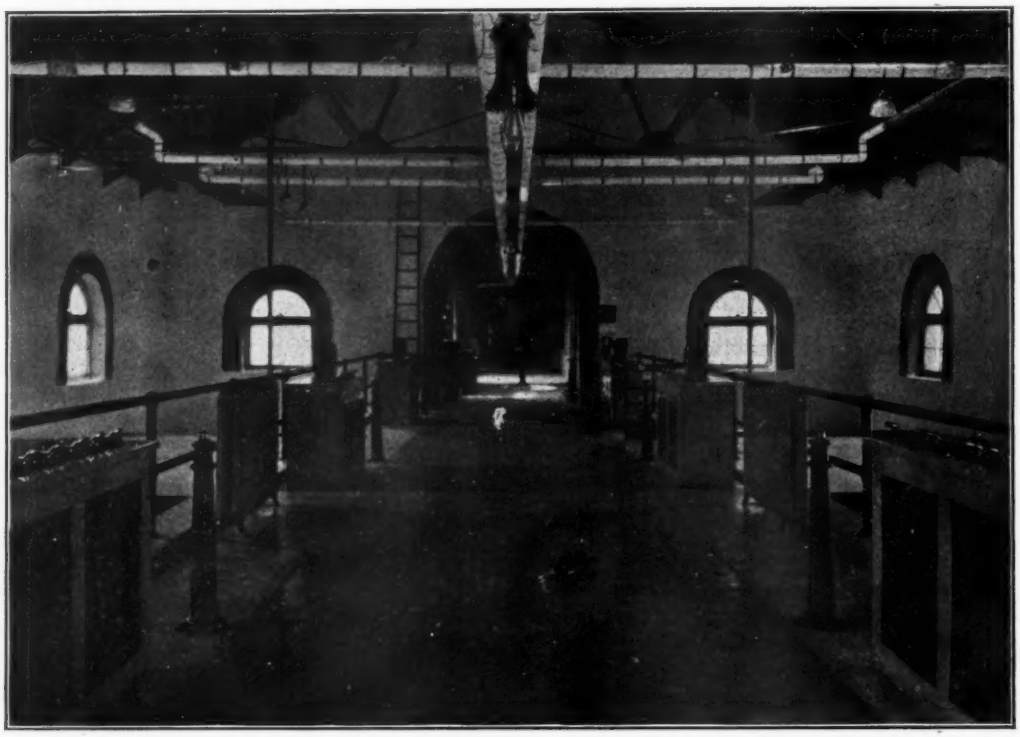
The decreasing velocity of the flow of the water as it moves outward thru the basins along radial lines, together with the excessive precipitation, yields a most excellent settling effect. Mention has been made of the large amounts of iron and aluminum sulphate ordinarily present in the river water. The iron in solution amounts usually to from 5 to 75 parts per million, equivalent to from 1 to 22 grains per gallon of crystalized ferrous sulphate, and there is also present about one-half this quantity of aluminum sulphate. The usual method of treatment for clarification is therefore reversed, it being necessary to supply the alkalinity to neutralize the acid and precipitate the iron and aluminum. The coagulants are usually present in large excess of the amount necessary for complete coagulation, and the natural result is a high percentage of removal of turbidity and bacteria in the settling basins. The effluent is occasionally perfectly clear and is quite clear most of the time, but would not be at all satisfactory as a city supply without filtration.

The sludge disposal system has been very effective in preventing the accumulation of sediment in the baffled mixing tank and settling basins. The basins have been drained for examination and

cleaning from time to time and have been found to contain very little sludge, except in several instances when some of the drains had become clogged.

The Filters

The usual burden on the filters is largely removed by the effective settling, and washing the beds is reduced to a minimum. The average service of a filter between washings is over 120 hours, and runs as long as 200 hours frequently occur. The per cent. of wash water to the water filtered amounted to 0.3 per cent. last year, which is remarkably low. While this condition prevails a large part of the time, there are periods of very turbid and alkaline water during floods, or even following a heavy shower, when it is necessary to add coagulants, and at such times the work of the filters is increased and the length of time between washings correspondingly diminished. The turbidity is usually coarse and easily removed, often without the addition of coagulants, but occasionally a very fine turbidity has been encountered, which is extremely difficult of removal. Analyses prove this material to be almost pure silica, and as the condition has always occurred after a rain following a period of highly acid water, it is thought possible that the acid leaches the soluble salts from the material in the beds of the streams leaving a skeleton of silica, which is loosened and washed down by the flood water. It has been suggested that sedimentation in the river may be responsible for this, the coarser particles settling out while the lighter silica remains in suspension. When the water is neutral or faintly alkaline, it is occasionally completely coagulated in the river and clarifies perfectly without any treatment whatever. As a safeguard, slight treatment is always given a water of this character.



MAIN WEIR BOX, *Mckeesport water purification plant.*

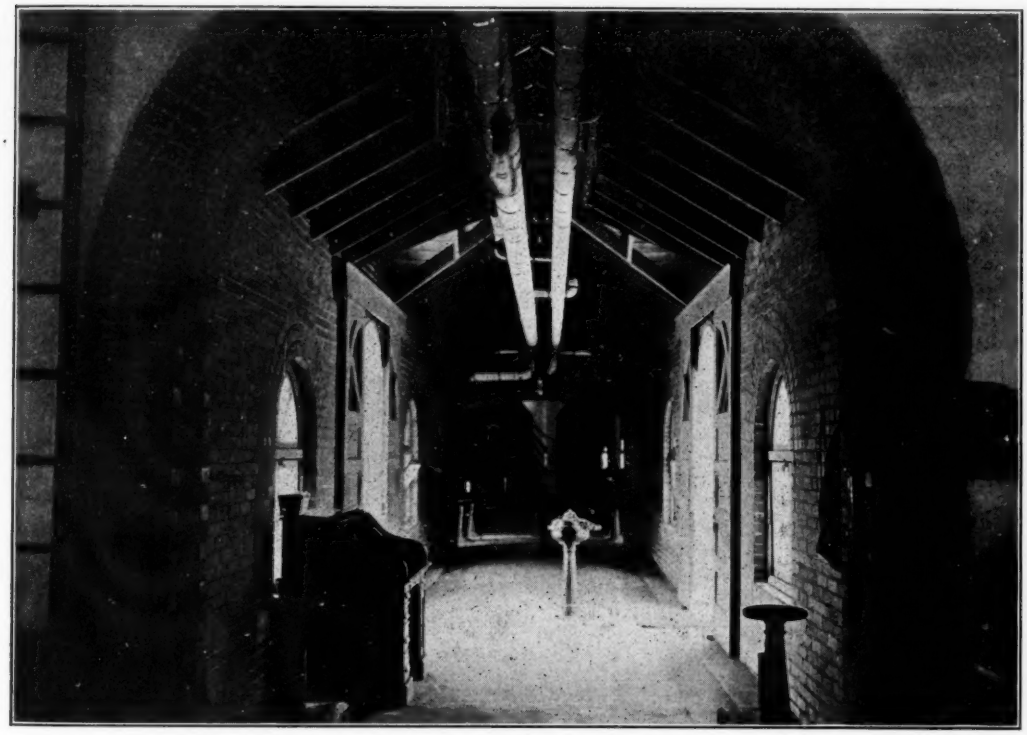
The "growing" or increase in the volume of the sand in the filters due to the sand grains becoming coated with car-

bonate of lime now amounts to about 300 percent. This incrustation has taken place at some other plants using lime and sulphate of iron, and the natural result of the increased size of the sand grains has been the lowering of the efficiency of the filters. On account of the exceptional conditions of coagulation and sedimentation here at McKeesport, the efficiency of the plant as a whole has not been affected to any extent. There has been no tendency toward cementing together of the grains and it is believed that the present sand can be used several years before it will be necessary to replace it.

General Conditions in 1912

The average hardness of the raw water was slightly greater than in 1909 and 1911 and much less than in 1908 and 1910. The conditions of hardness and acidity were much more uniform than during any other recent year. As in 1911 there was a fortunate distribution of the rainfall and no long period of high hardness and acidity occurred.

The operation of the plant was satisfactory and the high standard of purity of the filtered water was maintained.



ARCADE *connecting water softening and filtration plants, Mckeesport, Pa.*

CONSTRUCTION OF TILE PIPE SEWERS IN CHICAGO

By Herbert Edson Hudson, Division Engineer, Board of Local Improvements.

A STUDY of the growth of the population of Chicago shows several striking features. Many portions of the city have shown greater rates of growth than others. The city as a whole for the period 1900 to 1910 shows the remarkable increase in its population of 28.6 per cent. A large portion of this increase in population has been in the outlying districts. There has been a great tendency for the population to spread out over the level prairies and it is this great spread of population that causes the tremendous extension of main sewers and their laterals.

VITRIFIED PIPE, THIRTY-SIX INCHES DIAMETER, *going into sewer trench near Chicago.*

During the year 1912, the reports of the Board of Local Improvements show that there were constructed 69.82 miles of tile pipe sewer and 10.28 miles of brick sewer, making a total of 80.1 miles constructed during that year. The great main sewers in Western and Kedzie avenues had been completed at this time and enabled the construction of large tile pipe systems and perhaps accounts in a degree for the large amount of sewer built during that year. There are great portions of the territory included in the city limits which are not sewered at present or are very poorly sewered and there is a possibility that the figures for 1912 will not appear so large when compared with the future figures in the reports of the Board of Local Improvements. At this time they represent the largest amount of work done by the Board of Local Improvements during any one year. The figures for brick sewers constructed in

Cuts in this article furnished by Blackmer & Post.

1909 show a larger amount than for the year 1912, but the pipe sewer figures for that year are much smaller.

Tabulated for the years 1901-1912, inclusive, the figures are as follows:

Year.	Brick Sewers.	Tile Pipe Sewers.
1901.....	4.85 miles	12.67 miles
1902.....	4.25 miles	15.17 miles
1903.....	4.25 miles	29.39 miles
1904.....	6.68 miles	31.39 miles
1905.....	8.25 miles	23.93 miles
1906.....	14.71 miles	25.44 miles
1907.....	9.42 miles	42.95 miles
1908.....	16.01 miles	36.11 miles
1909.....	16.34 miles	50.79 miles
1910.....	15.08 miles	41.32 miles
1911.....	10.87 miles	54.50 miles
1912.....	10.28 miles	69.82 miles

A glance over the table shows a great predominance of tile pipe sewer construction. With little exception there appears to have been a steady increase in the rate of construction of tile pipe sewers during this period. The figures for brick sewer construction are subject to greater fluctuations, due perhaps to the extension of large main sewers, but the figures for tile pipe show a fairly uniform increase. During the period of growth covered by the percentage of 28.6 per cent. increase in population there is an increase in sewer construction of 26.5 per cent.

The construction of sewers by the Board of Local Improvements divides itself naturally into two classes—those contracts which are large enough to warrant the installation of machinery of one kind or another, and those which require the use of hand labor exclusively. In the last few years there have been great improvements in the utility of machines for sewer excavation and the construction of tile pipe sewers has been greatly facilitated thereby. The construction of brick sewers is nearly all of such a nature as to warrant the use of machinery. Only the occasional construction of short stretches of brick sewer is carried on with hand labor.

There are also many shorter blocks of tile pipe sewer varying from 200 feet to 700 feet in length which are built at this time in excavation made by hand labor. The construction of tile pipe sewer in machine excavation is found to be economical at this time on contracts covering as little as 1,200 to 1,300 feet.

There are several types of machines now on the market, all of which give different degrees of satisfaction when operated under the varying conditions met in Chicago. For the smaller sizes of tile pipe sewer, 12 to 15 inches, these machines excavate a trench wide enough for a man to work comfortably trimming out the bottom or laying and sealing pipe. For the larger sizes, 18 inches and over, the cutting edges of the machine may be changed or upon some types of machines the boom may be oscillated to accomplish the widening of the trench. Nearly all machines upon the market are so constructed that the spoil may be thrown at varying distances from the excavation. This feature enables the contractor to spoil his earth as near the trench as the quantity of excavation will allow.

It is customary in Chicago to set grade stakes upon work to be excavated by a machine in advance of the machine, at such an offset from the center line as will properly clear all parts of the machine. These stakes should should not be too far from the actual line of the work. The various types of machine used upon work of which the writer has had charge require offsets of 6, 7 or 8 feet. The stakes are usually set by instrument on a line parallel with the center line of the work so that the operators of the machine are enabled to keep a proper alinement upon the excavation. Grade stakes are given at intervals of 20 feet so that as soon as the machine passes one stake the workmen may level a cross piece over the trench and pull a line to the cross piece leveled from the last stake. This enables the contractor to lay pipe at all times within 20 or 25 feet of the machine, and when speed is essential it greatly facilitates the handling of sheeting and bracing. The pipe are gaged to the line between cross pieces by means of a gage pole. The writer has found that the best form of gage pole is a 1-inch-square strip 12 to 14 feet long marked off in feet and mounted at the bottom with an ordinary iron shelf-bracket. This bracket is rigid and not easily broken in the ordinary course of work. When a pipe is to be laid, a trowel of ce-

LOWERING THIRTY-INCH VITRIFIED PIPE *into trench. Chicago sewer construction, 1912.*

ment is thrown into the lower part of exposed bell of the last pipe laid and spread with the trowel up the sides of the bell so as to form a bed for the spigot end of the next pipe. When the next pipe is laid and found to be at grade, the pipe layer reaches as far as possible under the sides of the bell and seals it as perfectly as he can with cement. A single stroke of the shovel of the "bottom man" will serve to remove any excess of cement that may be crowded into the interior of the pipe. A good laborer can so trim the bottom that very little adjustment will be needed to grade the pipe properly. An ordinary pail of cement will seal three or four 12 to 15-inch pipe. On the larger sizes of pipe, the proportion of cement increases until on the 30-inch pipe a pail of cement is used in sealing one joint.

There is no trouble in raising or lowering a pipe to grade when the sizes are the smaller, 12 to 15 inches. When 18-inch pipe or larger sizes are used, it is the experience of the writer that a mark should be made on the gage pole that will allow for the thickness of the pipe and the necessary excavation for the bell. If the excavation is properly gaged by this means, every pipe will go into place and meet the approval of the most exacting inspectors. This method of testing the excavation was followed on work under the writer's charge on which 30-inch pipe was used. Upon investigation of the interior, it was found that there was practically no "lipping" anywhere—side, bottom, or top. It would be hard to imagine the interior of a sewer that would be more nearly perfect from sanitary, hydraulic, or construction points of view than this 30-inch sewer. With the proper bedding of the lower half of the pipe in its bell, the interior becomes almost a perfect cylinder.

The placing of the necessary connections or junctions for house drains and catch basin connections occasions some delay, as it is necessary to dig out the bank so they may be placed at the proper angle. The writer believes that these connections should enter the sewer slightly above the springing line, being tipped up to an angle of 15 or 20 degrees. This work is accomplished on the larger sizes of pipes with little delay, but causes more delay proportionately on the smaller sizes. The slants set for house drains are sealed off immediately with a tile stopper and cement. The catch basin slants set for basins to be constructed on the same contract are usually stopped off temporarily with two bricks and a cement bag until such time as the connection is properly made.

The large amount of work done by one of the machines in a day is one of the features of this type of construction. In 1912, the writer had occasion to see a machine excavate 1,040 feet of trench for 12-inch tile pipe sewer in a cut of 8½ feet. This work was done and a move of 900 feet was made during the day from the end of one stretch of 660 feet to the beginning of another similar stretch of work. Depending upon the size and power of these machines they will excavate the trench for 12 or 15-inch tile pipe sewer in amounts varying from 400 feet per day to the figure given above. The amount of work done in a day decreases as the size of the pipe increases, due both to the increase in excavation and the difficulties encountered in handling the larger sizes. On the 30-inch sewer mentioned, the day's work was about 200 feet. These larger pipe were lowered into

place by three or four men with little trouble. A small builders' derrick was provided upon one contract for 24-inch pipe but was found more expedient to lower the pipe by hand than to use the derrick and it was therefore abandoned.

The reports of the Board of Local Improvements 1901-1912 show an increase in the size of tile pipe used as well as in the quantity. Many of the contractors expressed the opinion that there would be trouble in handling the larger sizes. These fears, however, seem to have been groundless as those who have laid the 24, 27 and 30-inch sizes have expressed their satisfaction with the handling of these larger sizes.

On sewers built in trenches excavated by hand labor the procedure is much the same except that the engineer's grade stakes upon work under the writer's supervision are set in pairs at intervals of 25 feet—one on each side of the trench. By this procedure, the cross pieces carrying the line may be placed across the trench without the use of a level or without depending upon an employe of the contractor to see that the cross piece is level. In this method, there is also an opportunity to correct the error that would occur if a stake were driven low, by leaving its corresponding stake equally high. In a cut of 8½ feet in firm clay excavation, a force of 20 men and a brick layer will ordinarily lay 200 to 300 feet of 12 or 15-inch tile pipe sewer with necessary manholes and basins as a day's work.

In some parts of Chicago it is necessary to construct sewers in water-bearing sand or gravel. In many cases of this character, it is possible to drain the surrounding ground by opening a shallow trench and allowing the water to run off for two or three days. If the cut is deep, it is often advisable to sink sheeting in a second deeper cut and allow this to drain for a short time. If it becomes apparent that there is an abundance of water in the ground, it is often advisable to install a system of well points. These points can be sunk along the sides of the trench by the use of a water jet and serve to remove the water to such an extent that the excavation is apparently carried on in dry sand. On the smaller blocks of tile pipe sewer, these points are often connected with a diaphragm pump and this combination works fairly well. On the larger contracts, it is more customary to install steam or gasoline pumps to operate these well points. If the soil is porous and the water reaches the well point readily a vacuum of 6 or 8 pounds is sufficient to keep a steady stream of water flowing from the pump. If, however, the soil is composed of fine sand and silt or impregnated with clay, even the higher vacuums are not capable of drying the excavation. In many trenches that show a considerable amount of water after standing for a little time, work can be carried on with a considerable degree of success by sprinkling quantities of dry sand upon the portions being excavated and carrying on the excavation at the same time as speedily as possible.

FORTY-TWO INCH VITRIFIED SEWER PIPE, *ready for sewer near Chicago.*

When a sewer is built in sand excavation, the Chicago specifications require that all joints in the pipe work shall be calked with oakum. This is accomplished by placing a small rope of oakum in the lower half circle of the bell of the last

pipe when the usual trowel of cement is put in place. After the spigot end of the next pipe is inserted in this bell, the annular space surrounding it is calked with oakum driven home by the trowel. The bell is then sealed with cement.

The advent of the use of machinery for purposes of excavation has brought into the field another problem. For some time past it has been customary to backfill trenches by hand or by the use of teams and scrapers. Various methods have been tried, involving the use of plows, spreaders and scrapers pulled by horses. These methods were more or less satisfactory but have not greatly reduced the cost of back filling. At the present time, there is an effort on foot to use machinery of a lighter type for backfilling. As yet, there are no satisfactory machines used in Chicago for backfilling tile pipe sewer trenches altho there are several in the experimental stage. On the larger brick sewers, orange-peel grab buckets and clam-shells may be installed with economy. It is on the smaller sizes of sewers that the difficulty is encountered. A 12 or 15-inch tile pipe sewer trench, 8½ feet in depth, in ordinarily good ground is backfilled at a cost of 6 cents to 8 cents per lineal foot. This is the price prevailing for work done by teams and scrapers. In 1912, the trench for a 24-inch tile pipe sewer averaging 10 feet in depth was backfilled for 12 cents per foot. The surface of the street over the excavation is usually crowned 15 to 18 inches above its natural grade to allow for settlement. Even this crowning is insufficient in most cases and the contractors usually return after the first winter and trim up the surface of the street. The Chicago specifications require that wherever possible the trenches shall be puddled during the process of backfilling. When sewers are constructed in blocks where there are water mains or where water is available, this process of puddling is followed.

The reports of the Board of Local Improvements covering the last five years show the amount of tile pipe sewers constructed during that time and their cost, as follows:

Summary of vitrified pipe sewer constructed by private contract and special assessment.

Year.	Length in Feet.	Total Cost.
1908	187,697	$303,603.55
1909	266,888	392,284.72
1910	216,448	341,822.21
1911	284,540	415,725.74
1912	368,679	539,289.90

These figures, illustrating the amount of Chicago's sewerage work, represent, in a measure, the rapid increase of population in this great, growing city.

FAKE ADS MUST GO.

An ordinance prohibiting untrue and misleading advertising has passed the Los Angeles city council. This ordinance gives those who have been fighting for honest publicity an efficient weapon with which to force their object.

This ordinance follows closely and is modeled on the famous "Printer's Ink" statute, drawn by Attorney Sims of New York city, and already is a state law adopted in Washington, Minnesota, North Dakota, Indiana, New Jersey and Nebraska. It makes it a misdemeanor for any firm, person or corporation, to make or disseminate any assertion or fact concerning merchandise or service which is untrue or misleading. It covers every possible avenue of publicity, including newspapers, magazines, circulars, form letters, open publication, billboards, signs, labels, electric signs, window cards or by any advertising device or proclamation. A fine of from $25 to $500 or an imprisonment not exceeding 180 days or fine and imprisonment is provided for violation.

For more than a year the advertising club has been working with the backing of more than one thousand leading business men and more than half a dozen of the best civic organizations for some law which would put a stop to the fake sales that have often been carried on in Los Angeles. During the past few months nearly a score of prosecutions have been brought chiefly against fake auction sales and clothing concerns. At the present time the operations of these classes of business houses have been practically stopped and with a new ordinance in good working order it is expected that fake advertising will be put a stop to for all time.

MIXED METHOD GARBAGE AND WASTE DISPOSAL

By E. B. Stuart, Chicago, Ill.

THE description given follows the specifications of the garbage and waste disposal plant at Boulogne-sur-Mer, France, erected in 1911.

Capacity of Plant

The plant is officially rated as of 100 tons capacity in 10 working hours, one-half of the units being held in reserve; which means that the sieves separate, after defibration, 50 tons of fine siftings from 50 tons of coarse screenings, the former being destined for the fertilizer "le poudro" and the latter for gasification and combustion in the manufacture of electricity; or that more than the entire quota may be consumed in the production of electricity, without defibering or sifting. This would be an approximate capacity of 500 tons of mixed material in 24 hours. Even this latter qualification, however, is conservative, as there are four defiberers with an individual capacity of between 5 and 8 tons per hour, which would show a maximum capacity for the defiberer and sieves of 768 tons per day. Nevertheless, provision is made for combustion of the entire mass, should occasion require, so it will be seen that the plant has, by crowding every unit, an ultimate potential capacity of double this amount (i. e. 1,536 tons). These facts are dwelt upon as illustrative of the extremely rigid sanitary precautions prevailing among French cities. Boulogne-sur-Mer is, according to a recent census, a city of but 53,100 inhabitants. It is a seaport and center of the fishing industry, about thirty miles from Paris, and might, of course, be an entering place for the cholera or other plagues, which explains these extremely ample precautions.

Sanitary Unloading Station

In a recent meeting of the Finance Committee of the city of Chicago the possibility of a sanitary receiving station was suggested. Mayor Harrison, who was present, expressed doubts, stating that garbage, if left standing on a platform for only five minutes after unloading, was bound to give off odors which would be caught up by the winds and dispersed to the neighborhood. Our sanitary unloading station, and this is the only system that can boast of one, as will be seen by the drawings, consists of the following:

The garbage is collected in a hermetically closed wagon or cart of a special design, which by the throwing of a lever by the driver from the seat, is caused to dump its load.

Built to and projecting from and along a portion of one side of the main building is a shed-like structure with sides and roof of metal. This shed is open at the front, facing the wagon approach. Beneath the shed is a cement pit of the same dimension (about 20 feet by 12 feet), under which, but connected by an aperture about 2 feet wide in the bottom of the pit, is a tunnel in which runs a belt conveyor. In cross section this pit (patented) has the form of a trapezium. On the outer edge of the pit is an abutment, some 6 inches in height, protected by a stout oak sill. The driver from his seat pulls the lever, dumping contents of wagon onto the sloping side of the pit below. The garbage is then easily raked down to the bottom of the pit and thru the aperture onto the belt conveyor. This gives opportunity for a preliminary examination of the material received and the elimination of large debris or wires. The garbage makes but a short trip on this conveyor, when it is discharged onto a bucket elevator, which elevates it to a height of 67 feet, where it is discharged onto a belt conveyor leading to the various units of treatment.

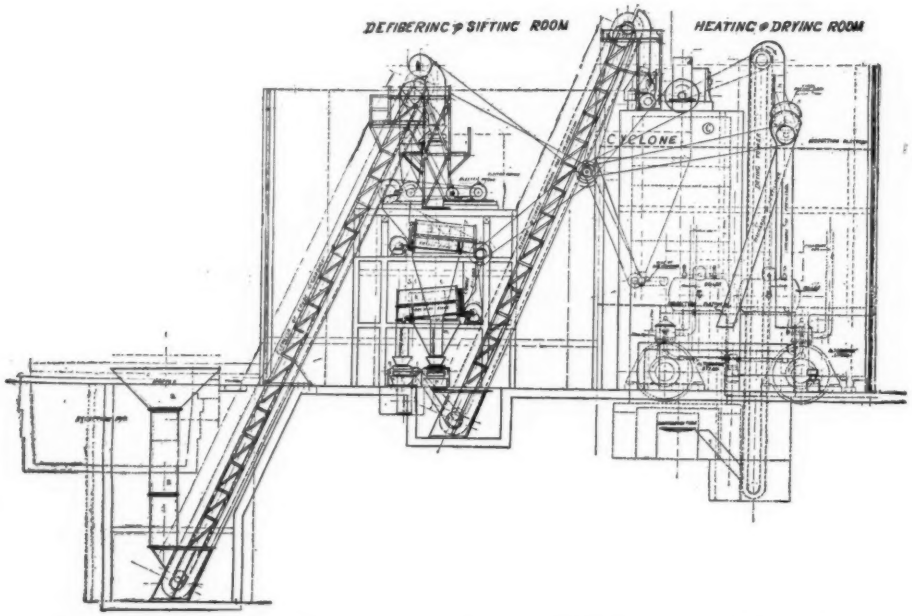
On the opposite side of the building is a track on which are shunted cars which bring in street sweepings, etc. via the street railway system. These cars are hauled by means of an electric cable up an inclined plane, at which point their contents are fed into a large hopper. The material unloaded here falls to the moving platform below and is carried up for treatment in the same elevator with the garbage. At the side of this hopper is a large receptacle capable, if necessary, of containing the receipts for 24 hours. It is held for emergency only. Both of these receptacles have lids which render them air tight when closed.

Conveyor System

The material is elevated some 67 feet by the bucket elevator and discharged thru a funnel onto a belt conveyor. This belt conveyor runs across the width of both the defibering and incinerating rooms and feeds five units of treatment. The belt passes thru a unique intercepting device called a "dump chariot," which, curling the belt over a series of rollers, (the whole apparatus movable along the traject of the belt) presents a discharge end. Material can thus be discharged into any one of the three funnels, each of which feeds two defiberers, or directly into one of three gas-making retorts, for conversion into gas and finally electricity.

Schoeller Crusher-Churn

The next step brings us to that wonderful machine, the Schoeller crusher-churn. The crude material from the overhead belt conveyor, by intervention of the dump chariot, falls into a bifurcated funnel, each leg of which feeds into one of these machines, known as a "broyeur." This apparatus is based on the principle of defibering by a shower of blows by articulated movable hammers fixed upon a beam turning at the velocity of 1,600 to 1,800 revolutions per minute. The hammers in their gyratory movement strike the garbage after the manner of flails; if too great an obstacle presents itself they give way, that is to say, they simply oscillate upon their



MIXED METHOD OF GARBAGE AND WASTE DISPOSAL. *Sectional drawing of design for plant, showing garbage hopper at left, defibering machine at top of center, sifting machines below, heating and drying room, fertilizer plant, incinerating furnace and boilers at right, elevators, conveyors, blowers, etc.*

axes, which obviates absolutely all danger of fracture. The garbage is completely pulverized, but substances of a resisting nature, such as rags, pieces of wood, etc., are merely torn, being ejected at the lower end of the sieve as combustible matter.

The transformation of the garbage, both chemical and physical, after passing thru the "broyeur" is remarkable. It issues from this machine as a fine damp powder in which only exceedingly fine fibers are visible, such substances as have not been defibered being found more or less together. The intense draft of air provoked by the churning causes a complete oxidation of the particles, and the matter which went in fermented or partially fermented comes out entirely without odor and partially dried, enabling it to pass easily thru the sieves below. These results are not accomplished by any other crusher.

Production of Le Poudro

From the "broyeur" the mixed damp powder and resistant substances pass to a large perforated metal sieve, which separates the fine matter from the coarse. The coarse matter which comes out of the end of the first set of sieves passes thru a secondary process of defibering and sifting below.

The fine damp powder next passes via belt conveyor onto circular revolving steaming table (exclusive patent) and is steamed to about 120 degrees Centigrade (254 degrees Fahrenheit), all organic life being destroyed. A vertical bucket elevator carries the steamed powder to the top of the drying tower. Within the drying tower are a series of fans, revolving around a central shaft. When thoroly dry the powder falls to a distribution table beneath, from which it passes thru an elevator to the final screen, the resulting dry powder, now the complete fertilizer, "le poudro," being discharged thru jointed sheet iron pipes into one or another of a row of push cars ranged below. It is then taken to the store room, bagged, sealed, labeled and, finally, as a complete assimilable organic fertilizer, is sold in bags or in bulk at the door of the plant at retail to florists, gardeners, truck farmers, nurserymen, etc.

On emerging from the "broyeur" the damp powder occupies slightly less than one-half the cubic space required for the original garbage, the weight being equal. Practically all organic matter, whether animal or vegetable, contains in the crude state about 70 per cent. of moisture. Considerable moisture is lost during trituration in the "broyeur." "Le poudro" as it comes out of the dryer contains but about 5 per cent. of moisture, altho it assimilates a certain percentage when exposed to the atmosphere.

Individual Control

There is a general power transmission shaft at low speed, and there are two secondary shafts at higher speeds, in addition to which, each important unit or set has its reserve motor, so that incapacitation of any unit or unit of transmission can only momentarily affect the operation of other units, providing the most complete combustion is secured, delay.

Manufacture of Gas

In the incinerating room there are three upright gas-makers or retorts. The coarse material ejected from the lower end of the sieves after the final crushing passes onto a belt conveyor, is elevated on the secondary inclined bucket elevator, again discharged on the overhead conveyor and dumped by the "dump chariot" into one of the three gas-makers, where, by means of a secret process (copyrighted) it is converted into gas, which is burned on jets beneath tubular boilers, the steam from which is converted into electricity. In this way the most complete combustion is secured, in the most sanitary manner, and with additional recovery of valuable fertilizing elements from the residues.

Value of Combustible Rubbish for Electricity

One hundred tons of combustible rubbish (which has about 1/5 the calorific power of the best coal) produces 500 kilowatts of electricity per hour during 10 hours, 10 kilogrammes (22,045 lbs.) of waste treated producing one kilowatt hour of electricity.

Four hundred k.w. per hour during 10

hours (80 per cent or 4/5 of the electricity produced) remains to be sold.

Collection of Ashes

In Paris the ashes from the households (but not steam plants) are placed in the same domestic receptacles and collected with the garbage and rubbish. This would not be advisable in the United States, especially in the North, where there is a much greater volume of ashes. It might be done for the convenience of the public, in certain districts where the amount of coal was not excessive and where limited space rendered two receptacles a hardship on the tenants, enforcing separate collection for the major portion and all manufactories and steam heated apartments.

Briquettes From Cinders, Scoria, or Ashes

The cinders from 100 tons of combustible rubbish consumed produce 14,000 briquettes per day, size 22 by 5 by 5 centimeters (approximately 9 by 2 by 2 inches). The cost of manufacture in France is $3.30 U. S. gold per thousand (which includes all expenses, interest on investment and sinking fund for brick plant). These bricks find a ready market for public or private works. If sold at the plant, a saving of possibly $2.00 per ton can be figured, as against the hauling and disposal of cinders. It should be remembered, however, that by this process there are no garbage cinders as in an incinerating plant, but only from dry rubbish.

Comparison With Incinerating Plants

Aside from the fact that an incinerating plant ruthlessly destroys values (apart from a modicum of electricity), the net cost, ascertained by the Municipal Council of Paris from the report of a committee sent to investigate in various European cities, taking an average of the results obtained, for the destruction alone, after deducting revenues obtained by the incinerating plant from the sale of electricity, is 50 cents gold per ton burned, not counting the expense of collection of garbage and wastes or the expense entailed in carting away the cinders, for which there is very little demand as an article of commerce, the available sink holes around European cities having been filled up long ago. This additional expense of carting cinders away was found to be $2.00 gold per ton, a very considerable item, in view of the fact that two tons of organic waste produce one ton of very inferior clinkers, having a slight agricultural value as a low grade fertilizer and a commercial value of less than the cost of reworking it for that purpose. In a large city this item alone would run up into the hundreds of thousands of dollars per year. On the other hand, the fertilizer "le poudro," which comprises all of the organic waste, is sold at the door of the plant and this expense is not encountered. In the utilization of dry combustible waste, there is only about 5 per cent. residue and of a quality suitable for the manufacture of briquettes or for paving streets. An incinerating plant will destroy in one year values several times exceeding its original cost of construction, a vandalism worthy of the Middle Ages.

The "mixed method," due to its great rapidity and thorogh oxidation and sterilization of organic matters, is more sanitary than incineration, whether or not steaming tables are installed. This is the opinion expressed by the National Congress of Hygiene of France (a branch of the Federal Government) and by resolutions adopted by the Municipal Council of Paris.

Economy of floor space, ready accessibility to every group and unit of machinery by the workmen, and general convenience of arrangements, have been very ingeniously provided for, the three preliminary groups being on as many floors, material passing by gravitation from one to another but each protected from noise, confusion or dust emanating from the others.

Ventilation of Plant, Smoke Consumption

So perfect is the consumption of smoke and gases that none escapes thru the chimney, of which there is but one, which is more in the nature of a ventilating shaft.

All unconsumed gases arising from the burning are gathered by an electric fan in a special construction of the furnace called a "corneau" (corner), drawn thru

the drying tower and back again over the fires of the furnace, until entirely consumed by the fire or absorbed by the fertilizer; a unique apparatus called the "cyclone" precipitates the soot, which is carried into the dryer by a spiral conveyor called the "way of Archimedes," and the soot enters into the composition of the fertilizer.

This is the best ventilated garbage plant in the world. In addition to the construction being of such form as to facilitate free movement of the air, powerful ventilators are also employed.

Technical Skill Employed in Creating System

The statement is often quoted that France paid her national debt after the Franco-Prussian war by utilizing the wastes of cities. This system was originated and improved by the engineers of Paris, assisted by co-operation from all municipal departments. In fact, it is a crystallization of the best results attained in France thru scientific experimentation, profound study and practical experience.

Extraction of Grease

It has frequently been stated by American and English writers on disposal matters, that the extraction of grease constituted the principal source of profit from a disposal system. While this is not exactly correct and greater success is obtained in France by this system than in the United States by a reduction system, yet there is considerably more grease in American garbage and the matter is well worth considering. The proportion of grease-bearing matter to the whole volume of organic wastes or fertilizer material is, however, not more than one-third or one quarter. By the defibering process of the "mixed method" the cubic volume of the material which could be treated for grease extraction is reduced 50 per cent. for corresponding weight and all non-grease bearing substances are eliminated by the sieves. Subsequent drying reduces the weight to 20 per cent., giving about 10 per cent. of the volume of the defibred and dried material, to work on, as compared with the original volume. The finer the disintegration of the particles to be treated by a naphtha process and the less moisture they contain the more readily the naphtha fumes penetrate the mass. That is to say, there is an open channel for the fumes around each particle of the disintegration. On a solid substance, such as a leg of beef, the fumes will act more gradually, causing decrepitation of the outer meat primarily, and in the course of hours reaching that around the bone, but with a mass in a dry state and of perfect defibration, the fumes will pass to every portion almost immediately, the contact with the cold surface of the separated particles precipitating the molecules of naphtha, which embrace the grease and carry them by gravity thru the channels prepared. All that is required is the addition of a residual oil extractor. As grease is worth at least $2.00 to the ton of pure garbage, it is an item worth considering. Arrangements have been made for providing the very best type of grease extractor when requested.

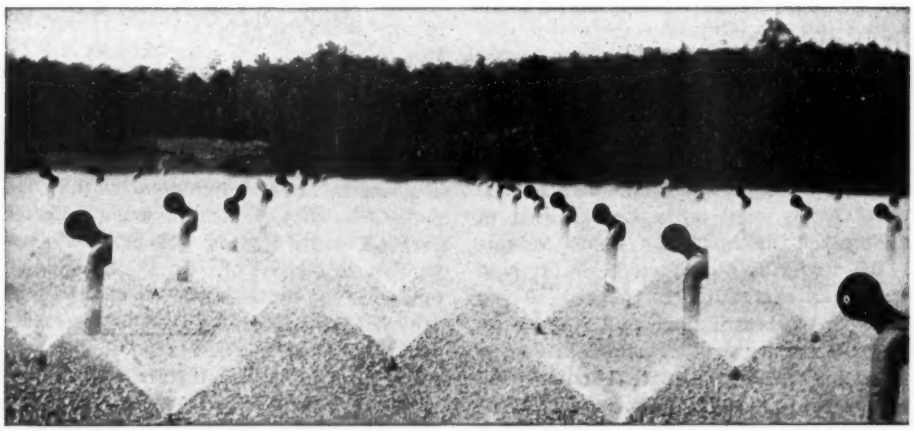
The Object of a Disposal Plant

The primary object of a disposal plant is the sanitation of the city and subordination to municipal convenience and economics. The highest expense connected with city waste disposal is its transportation from districts of collection to the plant. A plant designed for the sole purpose of extracting grease, it being possible to extract that commodity from only a small proportion of the wastes, is not in any measure adequate to the necessities of the situation. In Chicago, for instance, incinerators strategically posted to save excessive hauls (seven miles by wagon in some instances and averaging very long) would undoubtedly be more economical for the municipality than the method employed of delivering selected garbage, only, leaving the balance more difficult to dispose of. On the other hand plants of the "mixed method" have every sanitary advantage of the incinerators and can be as conveniently disposed at stragetic points, saving this excessive cartage expense to the city. These plants dispose of effectually and yet conserve the values of everything treated which has a possible value. Conserving the organic wastes of Chicago, in the form of this magnificent fertilizer, sold at a

low price, would have a marked effect in reducing the cost of living to the population of the city, as it has done around Paris and other cities in France, by making the near-by truck farms more productive.

Market for "Le Poudro"

An explanation should be made as to the expressions which have crept into use among the chemical fertilizer manufacturers. The terms "low grade," "high grade," and "commercial," are highly misleading. An organic fertilizer does not inherently contain any larger percentage of the essential elements of fertility than were enclosed in the living substance of the constituted organism, altho the physical condensation brought about by defibration and loss of moisture renders it correspondingly richer. In the introduction of the pamphlet from which these facts are taken, appears a testimonial, highly enthusiastic like thousands of others rendered voluntarily to the French company. If an agricultural expert can obtain 25 barrels of wine from the grapes of old vines which in their prime when treated with the so-called "high-grade commercial fertilizers" yielded but two barrels, he is justified in calling it a wonderful fertilizer, and if it is wonderful it is certainly high-grade in every commonsense acceptation of the term; moreever, the people want such a fertilizer and are glad to have the opportunity to buy it, and if so, it is commercial. To use common speech expressions as technical terms, indicating certain preparations of chemicals, is dishonest in sum and substance. It is a trick of the trade and the fertilizer trade is in the hands of a few powerful manipulators, both of "the cost of living" and of simple English. There is a world of evidence to show that even common horse manure is a more valuable and complete fertilizer than most of the so-called "high grade" mineral fertilizers, but millions of horses have been deposed and the people must pay the bill because the automobile does not produce a good fertilizer. City wastes do, however, and it is a manifold crime to destroy them by incineration or fail to utilize them in the best manner, which is in the production of "le poudro." This fertilizer is sufficiently concentrated to give a good chemical analysis, but its capacity for producing results is simply marvelous.



390 TAYLOR NOZZLES *at Atlanta, Ga., operated by two 24-in. Miller Sewage Siphons.*

MOTOR TRUCKS IN MUNICIPAL CONTRACTING

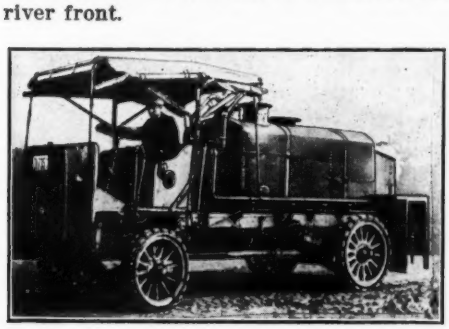
By H. W. Perry, New York.

ONE of the biggest engineering jobs on which motor trucks have been used extensively is the Catskill aqueduct, to provide Greater New York with a new and adequate water supply. The Pittsburgh Contracting Co., which has the contract for construction of a section of the aqueduct more than five miles long, extending from 106th street northward thru Harlem and the Bronx, is using a fleet of thirteen motor trucks. There are three each of the White, Vulcan and Sauer trucks and seven Garfords.

Most of the fleet have very heavy plank platforms adapted to receive steel dump bodies made independent of the chassis, so that they can be lifted off the platform by a crane, which swings them off the truck and up-ends them to discharge the contents at the dump.

The dump in this case happens to be a fill along the shore of the Hudson river from 116th to 129th streets, for which the Pittsburgh company also has a contract.

Debris from the bore for the aqueduct deep down under the city is brought to the base of the shaft at 106th street in dump cars, hoisted to the surface and emptied into huge hoppers fitted with chutes. From these it runs into the dump bodies on the trucks and is hauled to the river front.



HEWITT MOTOR-DRIVEN ROAD-OILER.

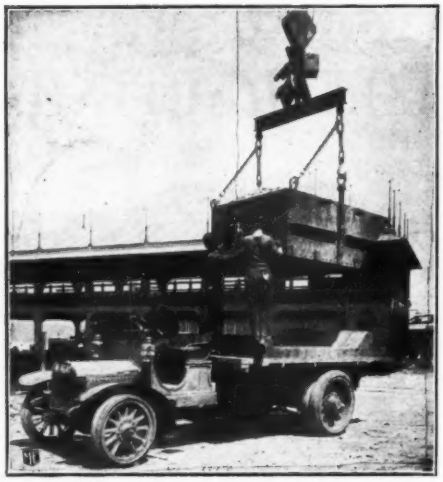
The trucks are operated twenty-four hours a day, exclusive of the three half-our periods when the three shifts of workmen stop for lunch. At these times the vehicles are inspected, oiled and the fuel replenished when necessary.

GARBAGE TRUCK *used by Seattle, Washington, Health Department. Pierce-Arrow Truck.*

A fair idea of the service given is obtained from the record of one truck from February 20 to March 19, inclusive. During this period of twenty-eight days, including four Sundays, the truck made 535 trips aggregating 1,592 miles. As the body has a capacity of four cubic yards, this truck hauled between 6,000 and 6,500 yards of material in the month. It made no trips on two Sundays and only nine trips on each of the other two.

From 4 to 4½ minutes are required to load the trucks with the contents of two of the two-yard tunnel cars, and only about 2½ minutes to dump the four-yard load by crane at the fill. Aside from these short waits, about the only other loss of time is occasioned by waiting for another truck to get out of the way, which does not occur often and is of short duration. Running time averages 10 minutes. A full round trip occupies an average of one-half hour.

By the use of motor trucks the operators have gained a great deal of time be-



MOTOR TRUCK BODY IS REMOVABLE SKIP BUCKET. *A five-ton Saurer truck, with body handled by a crane with a derrick boom.*

sides effecting a dollars and cents saving estimated at 20 to 25 per cent. This is important, because the huge task must be finished by the end of next year. Actual records of the work of one of the five-ton Saurer trucks on this job, according to the manufacturers, show that the cost of haulage with it was 29 cents per cubic yard as against a cost of 80 cents per yard by horses, or a saving of 63¾ per cent. This truck is shown in a photograph.

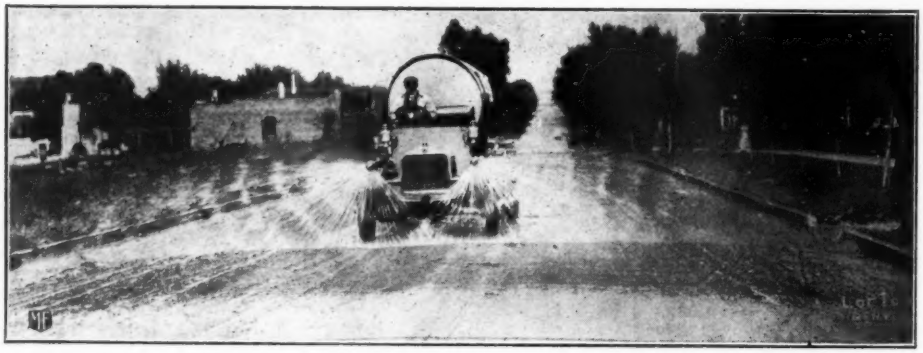
Aside from the advantages to the contractors, this truck service is a great boon to the city. If the contractors used horses, they would need to use at least four or five times as many teams both day and night, with the resultant congestion of traffic and inconvenience to the public in a busy section of the metropolis.

Smith, Hauser & Locker Co., who have the contract for another section of the aqueduct, nearly four miles long and farther downtown, are using a fleet of half a dozen motor trucks, also with good results. All of the cement, sand, gravel and other material and supplies for doing the concrete work are hauled by the power vehicles, working three shifts a day. The sand and gravel arrive in barges at the dock on the East river, where a crane and scoop unload them into hoppers having chutes. An average of only 16 seconds is required for loading five cubic yards of sand and 2½ minutes for loading the same quantity of gravel. A photograph shows the methods of loading from hopper and with grab buckets.

The trucks have rear dumping bodies and discharge their loads thru an opening level with the street surface. Dumping occupies about three or four minutes.

Entirely apart from the use of motor trucks for simple transportation of materials in contract work, the power vehicle lends itself admirably to many special purposes. The power plant which it possesses is frequently used for auxiliary power purposes in ways that are impossible with horse-drawn vehicles.

In street and road construction it has been found especially useful in applying crude oil and tar preparations to the surfaces. The Locomobile, Knox and Inter-



MOTOR-DRIVEN STREET SPRINKLER *with nozzles in front, preventing dust raising by wheels of the machine. Can sprinkle 80 feet width. Photograph is of machine in operation in Denver, Colorado.*

SPECIAL LOADING DEVICES FOR CONTRACTORS' TRUCKS. *Garford trucks loading from hopper and from grab-bucket handled by crane.*

national companies have all built special machines for this purpose. In and around New York a good many miles of bituminous macadam boulevards and roads have been laid. These require the application of a grade of coal tar having a large content of solids, followed by lighter grades of crude petroleum. A Locomobile truck built for this service has a large cylindrical steel tank body having pipe coils inside thru which the exhaust gas from the engine is conducted for the purpose of keeping the tar hot and in a sufficiently liquid state to flow readily thru distributing tubes under the rear end of the truck. In operation, the truck takes on a load of binder, hauls it any required distance to the stretch of road to be treated, and there applies it without loss of heat to the layers of crushed stone. A gear pump forces the liquid thru the nozzles, different sizes of which are used for the several grades of oil.

There is added economy in employment of the power vehicle in this way, because it is not necessary to establish tar and oil stations and heating apparatus so near the scene of operations as with the horse-drawn apparatus. Hauls of fifteen to twenty-five miles are not uncommon, and roads have been built as much as fifty miles from the coal tar supply. The truck makers are authority for the statement that use of the tank truck renders it possible to build bituminous roads at costs as low as or lower than that of the water-bound macadam roads heretofore laid.

Nearly thirty oil-spraying motor trucks are now used by the Standard Oil Co. in Massachusetts, New York, New Jersey and Pennsylvania. These are used principally for oiling the ordinary macadam road for the double purpose of laying the dust and preserving the road surface. Heavy crude oil is best for this purpose, and it is preferable to apply it with force so as to cause it to penetrate as deeply as possible into the road surface. The Hewitt, Mack and Saurer trucks employed are equipped with Gould rotary and Kinney eccentric pumps. These are gear-driven from the truck transmission gears or from the main propeller shaft, and provided with clutches operated from the driver's seat. The oil sprays are actuated under a pressure of from 80 to 120 pounds.

By the use of these trucks with force

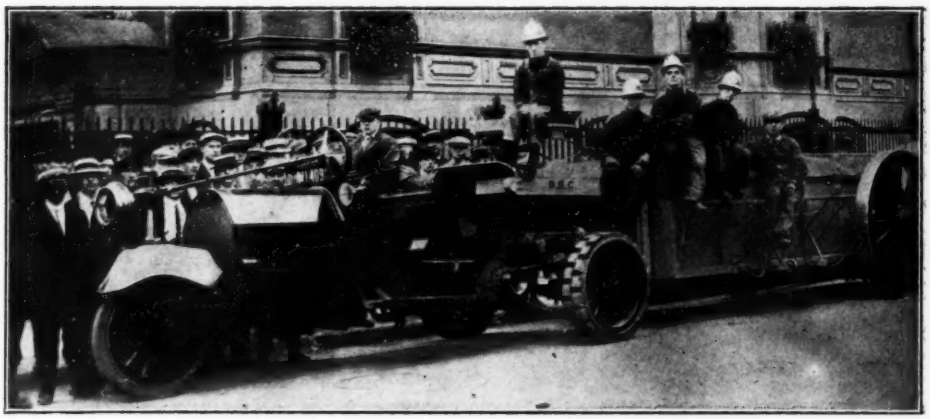
ASH WAGON *of ten tons capacity used in Brooklyn, hauled by tractor.*

distribution, the contractor can use a heavier, lower grade oil than where the gravity feed is used. This oil is from three to four cents a gallon cheaper and lasts longer after application. Furthermore, owing to the faster travel of the power truck, the oil film can be spread thinner than by gravity, so that as little as one-twelfth gallon per square yard can be applied. The speed and direction of the truck can be regulated to a nicety, so as to get uniform distribution over the whole road surface. When desired, emulsified oil can be used by adding water to the oil in the tank, then pumping the oil thru a system of strainers contained in the tank. In the fall, after road oiling ceases, the tanks and spraying device can be removed from the trucks and ash, garbage or other bodies substituted for winter work. One of these oil sprays is shown by photograph.

While on the subject of streets, it is appropriate to show other special applications of motor vehicles. Self-propelled sprinklers have been in use in a number of American and European cities for years. The simple gravity system was first used, but recently this has been vastly improved upon by fitting power pumps which force the water far out on either side, so that the entire width of a street can be sprinkled at one trip. The city of Denver operates one of these motor sprinklers that waters an 80-foot street from curb to curb in one operation. The tank has a capacity of 1,400 gallons. According to Superintendent of Streets Geary, this machine saves the city $26 a day, or about $5,000 a year over horse-drawn sprinklers. It covers nearly fifty miles of streets in an eight-hour day. As shown in the photograph, the nozzles are in front instead of at the rear.

The company that has the contract for sprinkling the streets of St. Louis has purchased twelve Smith-Milwaukee motor sprinkling trucks, which are doing the work formerly done by fifty horses and which will do all the sprinkling for the whole city.

MOTOR TRUCK AS SNOW PLOW, *did the work of two hundred men.*



LOW BED GARBAGE TRUCK *hauled to dump by Knox-Martin tractor. Horses haul the rear bed from house to house for collection of garbage which when full is exchanged for an empty one brought by the tractor. Exchange easily made by jacking up front end of bed.*

Power trucks are assisting in the solution of the quick and economical removal of ashes, garbage and snow by the street departments of a number of cities. The New York street cleaning department recently began experiments to determine the adaptability of trucks to this service, and has succeeded in getting a type of truck body that permits of dumping the load off the end of the dock into scows in the river without any danger of overturning the truck, as will be seen from the photograph.

A unique plan that has been tried is the collection of garbage from house to house with a huge truck drawn by horses which, upon being filled, is left at a prearranged point to be hauled to the dump by a motor tractor. The front end of the body is jacked up and the horses and front wheels are driven away with an empty body to continue collection. The tractor, upon returning from the dump with an empty, leaves the latter and backs under the front of the full body, which is coupled on with a king-bolt and hauled away. The tractor is the Knox-Martin three-wheeled machine shown in some of the illustrations.

One of these tractors is used by the Borough Development Co., of Brooklyn, for hauling ashes from the industrial plants in Brooklyn to scows in the East river. For this work a huge steel body of twenty cubic yards capacity was especially built and mounted on a pair of 54-inch wheels shod with 7-inch steel tires. The tractor is driven by a 50-h.p. engine and in this case the pair of rear drive wheels are also fitted with steel tires. Thus the entire load, amounting to about fifteen tons, including trailer and its load, is carried on steel tires, so that the expense of rubber tires is avoided.

Cost of hauling with such an outfit has been determined to be about 10½ cents per cubic yard, or 4 cents per ton mile, as compared with 54¾ cents per cubic yard, or 20¼ cents per ton mile, with horses. These figures will vary, of course, with the conditions surrounding the use of the tractor. They include all items of operation and maintenance, such as driver's wages, fuel, tires, oil, garaging, interest, depreciation and insurance.

Motor trucks have, in a number of instances, been used for snow removal. A unique case of the conversion of a truck into a snow plow is illustrated in one of the pictures. A 7½-ton dump truck owned by Joseph Murphy's Sons, who had a contract with the city of New York for snow removal, was fitted with an improvised snow plow and put to work. The contractors reported that they could do as much work with this in a day as with 200 snow shovelers. This indicates one of the great possibilities of the motor truck that has not been developed.

YIELD OF LIMESTONE AND SANDSTONE WELLS

THE yield of wells large enough to be considered as sources of water supply for cities or towns whether large or small has been studied quite thoroly by the United States Geological Survey. The conclusions to be drawn from the facts published in various Water Supply Papers issued by the survey have been very fully stated in a paper before the New England Water Works Association by Myron E. Fuller, consulting engineer, Boston, Mass., who was for some time in charge of ground water investigations for the Survey in its eastern district.

The following concerning wells in limestones and sandstones is taken from this paper and will be of interest to water works men in many sections, where supplies, present or prospective, or additions thereto, must be drawn from deep wells running into rock strata of these classes.

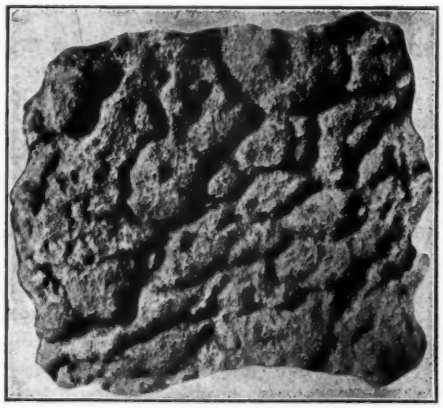
Wells in Limestone

Limestones have an average porosity of about 5 per cent. and will hold about 1.5 quarts of water per cubic foot, or some 85,000,000 gallons within a radius of 500 feet of a 300-foot well, but, as in slates and granites, this is so strongly held by the force of capillarity that practically none of it is available to wells.

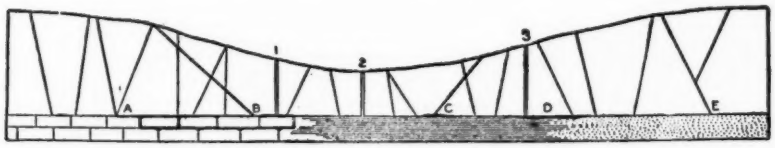
The available supplies from limestones come, in nearly every case, from solution passages. These are dissolved by percolating waters wherever there is an opportunity for circulation, generally along some fault, joint, or bedding plane, especially at the contact with some shaly or other impervious layer. At first the openings are very small, usually only a fraction of an inch in diameter, but there is a general tendency for the water movement to become concentrated along certain lines, with the result that tubular passages, varying from a few inches to many feet in diameter, are eventually formed. The smaller passages often form a ramifying network along bedding planes.

The largest passages are usually formed at or above drainage level, that is, above the level of the valleys into which the limestone waters drain. Our well-known caves such as Mammoth, Wyandotte, etc., are examples of this type. At great depths the circulation of water is less rapid and the passages are smaller. Nevertheless, as indicated by waterworn specimens brought up in drilling, passages a foot or more in diameter occur at depths of more than 1,000 feet. The length of the larger passages is often considerable. One passage in the Mammoth Cave of Kentucky is nearly 5 miles in length, while certain surface features, such as great sinks, indicate that passages of several, if not many, times this length may occur.

The water supplies of limestones, unlike those of most other classes of rocks, are not solely and possibly not even chiefly dependent on the presence of overlying soil or other feeders. A large quantity of water, on the contrary, passes downward



RAMIFYING CHANNELS *along bedding planes in limestone, produced by solution of lime in water, showing opportunity for circulation of water in limestone rock formations.*



SECTION ILLUSTRATING THE FEEDING OF WATER BEDS IN ROCK THRU JOINTS IN ROCK LAYERS. *Water bearing joints are indicated by the heavier lines. A, B, is water bearing area between limestone and a compact, jointed rock fed by joints at A and B. C is a water area between shale and compact jointed rocks, which has only a local circulation. D is a water area fed from a sandstone bed. E is the sandstone bed fed by joints. There is a flowing well at 1 fed from the bedding plane between limestone and compact jointed rocks, A B. The well driven at 2 was a dry hole, there being no circulation of water along the bedding plane at this point. There is a flowing well at 3 from the bedding plane D which is fed from the sandstone E.*

thru sinks or basin-like depressions connecting with the underground passages. Thru these, the surface waters enter the rock directly and without filtration. Whole streams, sometimes flowing millions of gallons a day, sometimes disappear into cavernous passages in the limestone.

From the preceding it will be apparent that the free water in limestones will far exceed that of the granite rock and the slates and shales, and will often, as a matter of fact, be sufficient to supply a well indefinitely without the aid of the usual feeder.

The ramifying networks of small passages, previously mentioned, are more dependable sources of supply than are the large passages, since they are generally of considerable lateral extent as compared with the tubular passages. A well may miss the latter entirely, even tho there may be several in its immediate vicinity, but it will rarely fail to encounter at least one of the broader bedding planes. The supplies of the latter, however, are usually more limited than those of the big passages.

Topography is a far more important factor in determining the yield of limestone wells than of those of any other class of rock. The reason for this is the open character of the water-bearing passages, which commonly permits the limestone waters to freely drain into the adjacent valleys, thus preventing the accumulation of reserve supplies. Large permanent supplies are seldom found above drainage or valley level, except where large streams of moving water are encountered. Often it will not be the valley nearest to the well that will determine the drainage level, but rather some distant valley into which the underground stream eventually discharges.

It is to be borne in mind that whenever limestone wells are considered as a source of public supplies, there is always considerable danger of contamination, owing to the entrance of much of the water into the ground through sinks and without filtration. Such waters must always be carefully watched for any sudden increase in chlorine or the appearance of bacilli coli.

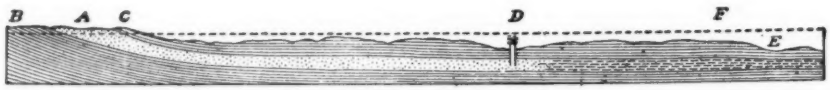
Yield of Wells in Limestone

The yield of limestones, except where very near the edge of a valley into which their waters may drain, will average not less than 50 per cent. greater than those from slates and shales. The maximum possible yield of limestone wells is many times that of wells in the latter rocks. Compared with sandstones, on the other hand, the average yield of wells in limestone is comparatively small, although individual wells encountering large solution passages may run as high or higher than the largest sandstone well. In southeastern Minnesota practically every one of the scores of public supplies derived from rock wells obtains its water from sandstone, although limestone is equally and often even more convenient of access and its water equally good from the chemical and sanitary standpoint.

The average yield of a limestone well under unfavorable conditions, as on slopes

with thin coverings, is probably about 25 per cent. less than that of a sandstone well in the same situation. Below drainage level and beneath thick coverings the average yield of limestone wells is estimated to be 50 per cent. to 75 per cent. less than wells in sandstone.

It is not considered advisable, owing to the excessively wide variations of individual wells, to attempt to show the probable average yield of limestone wells by means of a table. The foregoing comparisons will, however, afford a fair idea of the quantities to be expected from wells of this class. It may be said that, in general, limestones will afford ample water for domestic and farm purposes, and, when beneath drainage level, will ordinarily furnish sufficient quantities to supply small villages and occasionally large villages and even towns of considerable size. The yield of limestone wells is not usually materially affected by their diameters, except insofar as the size may limit the capacity of the pumps used.



SECTION ILLUSTRATING FLOW OF WATER IN INCLINED POROUS BED.
A is a porous rock stratum between impervious beds B and C, thinning out at E, so that a flowing well is possible at D but not at F. A may represent outcrop of St. Peter sandstone in Wisconsin, and D flowing wells at Cincinnati.

Wells in Sandstone

The greater part of the water in sandstone occurs, as in most other rocks, in the pore spaces between the grains, but unlike the rocks previously considered, these pore spaces are large, mostly supercapillary, and usually give up the larger portions of their supplies to wells.

Most sandstones are composed of mixtures of coarse and fine grains, which are bound together by cements of lime, silica, or iron. The extent to which these cements have filled the original pores and thus partially closed the intercommunicating passages between the pore spaces regulates, to a large degree, the freedom of movement of the water within the rock, and largely determines the yield to wells. Inasmuch as the cementing is naturally more complete where the grains and pores are small, it follows that the presence of fine material, especially silt, in sandstone is an important factor in determining yield.

In the finer and more silty sandstones which have, let us say, an average porosity of 5 per cent., only about one-fifth will be yielded to wells, while four-fifths of the water will remain permanently in the rock. In the more coarse and open varieties, whose porosity is sometimes as high as 25 per cent., about three-fifths will be yielded to wells and only two-fifths remain behind. In the first instance the yield will be equivalent to 0.3 quarts to each cubic foot of sandstone; in the second, to 4.5 quarts. The yield of a rock holding the latter quantity, if it is of any considerable thickness, is enormous. with a bed only ten feet thick there would be stored in a single acre 1,176,000 gals. Since a well in sandstone may draw from scores if not hundreds or even thousands of acres, the possibilities of obtaining large supplies for public purposes are usually very good.

Although a sandstone bed is usually more or less saturated throughout, the movement of the water, owing to the compactness of grain, may be comparatively slow and the direct yield to a well somewhat limited. Usually, however, there are more or less well-defined bedding planes in the rock, and to these the waters are delivered from the pores over considerable areas. A well encountering such a bedding plane will obtain far more water than it would otherwise secure. There is also a strong tendency toward concentration of movement within the rock along beds or layers of shale.

Joint-planes play a far less important part in determining the water-bearing capacity of a sandstone than in the crystalline rocks and slates. Nevertheless,

they sometimes afford passages for large quantities of water. This is especially true where there has been faulting along the joint-planes and the rack has been more or less crushed and broken. The exceptional yield of certain wells at Hartford, Conn., which is from three to five times that of the usual well in similar rocks in the vicinity, is attributed to such a crushed zone.

The actions of the soils or other feeders overlying the outcrops is much the same as in other rocks, but since the sandstones are themselves absorbent, the presence of feeders is not so vital.

Topography has a strong influence on the yield of sandstone wells. It is not so much, however, that the rainfall is quickly shed from the slopes as it is that the sloping surfaces cutting the sandstone beds permit the easy escape of their waters.

Yield of Wells in Sandstone

The average estimated yields of wells in sandstones of different types and under varying conditions of topography and depth are given in the following table.

ESTIMATED YIELD OF WELLS IN SANDSTONES.
(In Gallons per Minute.)

Diam. of Well. (Ins.)	Fine to Medium Grained and City Sandstones. Depths 100 to 300 Feet.				Coarse or Open Sandstone. Depths 100 to 300 Feet.			
	Slopes.	Upland Plains.	Valleys.	Deep Wells.	Slopes.	Upland Plains.	Valleys.	Deep Wells.
4	15	30	40	45	20	100	125	150
6	20*	40*	60*	70	25	150	200	350
8	25	50	70	85	30	200	250	500
10	30	60	80	100	35	250	300	600

*Actual averages computed for 90 wells in Connecticut are 17, 43 and 64 gal. per minute respectively for slope, upland plain and valleys wells.

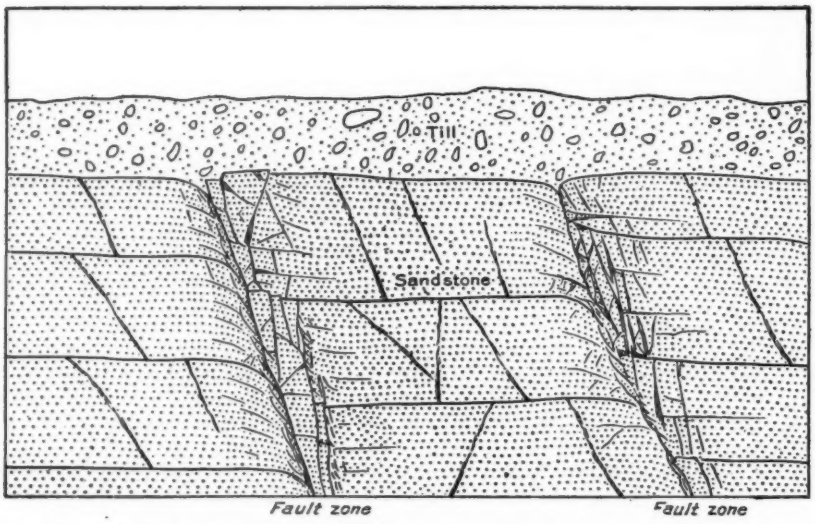
As in other rocks, individual wells in sandstone vary greatly from the average yields according to local conditions. No well in sandstone, however, unless near the immediate edge of a sharp drop, will fail to get some water, and under favorable conditions the supply may reach 1,000 gals. a minute or more, or upwards of a million and a quarter gals. per day.

The diameter of the well is of more importance in drilling in sandstone than in most other rocks for the reason that water enters from every point on the sides and any increase of exposed area tends to increase the rapidity of entrance of the supply. The effect is greatest in the silty sandstones. In the very open varieties the diameter is less important, as the water is often able to enter as fast as required by the pumps regardless of diameter. Large diameters are of advantage thru the increased size of pumps that may be used.

The small yield of wells of moderate depths (100 to 300 ft.) situated on slopes is due to the fact that, while the bottom of the well may be below drainage, the head of the water which determines its rate of entrance is relatively low, owing to the drainage of the supplies from the upper rocks. Under hills and upland plains this leakage is not so important, and the yield of wells is noticeably higher. Under broad plains the quantity afforded by a well approaches that given by one in the valley. Deep wells, under which head may be included those from 300 to 1,000 ft. or more in depth having not less than four-fifths of their depth below drainage level, give still larger supplies.

The yields of the table are for sandstones of the ordinary types. The dense hard varieties, such as occur in the vicinity of Boston, in Narragansett Bay region, etc., often approach quartzites in character. In such rocks the water supplies are determined by the jointing, and vary but little in quantity from those secured from quartzites and granites.

Owing to the open character of the

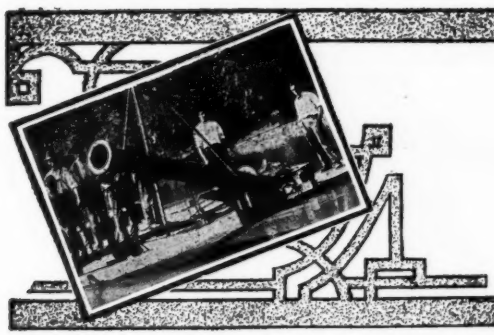


SECTION SHOWING FAULT ZONES *in Sandstone, from wells in which water can be obtained.*

rock, adjacent wells in sandstone almost always interfere with one another if the withdrawal is in excess of the inflow from other parts of the rock. The yield of nearby wells may be less than 50 per cent. of the sum of their yields when pumped separately, but one well seldom robs the entire supply of its neighbors, as is sometimes the case in granite, shale and quartzite wells. When the water-bearing sandstone is of considerable thickness and the replenishment rapid, the wells may often be pumped to their full capacity without serious interference.

The sandstones of the Connecticut Valley are medium grained and somewhat silty. Their average quantitative possibilities as sources of public supply are fairly well shown by the table, although locally the supplies will run much higher. Their mineralization must, however, be carefully considered in connection with any project for their development.

In the west, the Dakota and other sandstones furnish water for scores if not hundreds of villages and towns, the consumption of some of which reaches several million gallons per day. Over broad areas these sandstones are unfailing sources of supply where the demand does not exceed one or two million gallons a day.



EDITORIAL

CONCRETE PAVEMENTS.

Probably the most difficult of all the concrete construction problems which engineers have had to face and solve is the proper design and construction of concrete pavements. Although only a comparatively recent innovation, attended with the usual costly failures and experiments of any new type of construction, surprising progress has been made. Engineers can recall the difficulties that marked the early stages of the simplest types of concrete structures which taught the lesson that concrete is merely a structural material, subject to certain laws governing strength, elasticity, etc., and they have profited by this initial lesson.

It is obvious at a glance that the considerations involved in the construction of concrete pavements are more complex and multitudinous than in building or foundation work, but it is not generally understood as yet just where the marked differences in the two types of construction lie.

The articles in this and the preceding issue of MUNICIPAL ENGINEERING, by Morse-Warren Engineering Co., of Carlinville, Ill., are worthy of note. The authors have made a practical and scientific study of both design and construction, and the resume of their experiences and observations is not only highly illuminating, but represents one of the first practical treatises on a problem which has hitherto been subjected to various vague theories.

A PROBLEM IN PUBLIC SERVICE CORPORATION REGULATION

The Citizens Gas Company of Indianapolis as described in articles in earlier numbers of MUNICIPAL ENGINEERING, is paying 7 per cent dividends with gas at 60 cents. Its stock is voted by a self-perpetuating board of trustees so that it is not subject to manipulation. Profit beyond 10 per cent cumulative dividends on the stock must be used in retiring stock and when stock is all retired the plant belongs to the city. But profits can be kept at 10 per cent by reducing the price of gas.

The Indianapolis Gas Company is an old line company which by its own showing was not able to sell gas at 75 cents until after the 60-cent gas was a demonstrated fact, but is now claiming net profits of over $90,000 a year on 60-cent gas with still further profits in sight when the new coke-ovens are put in operation. These profits are sufficient to pay only about 1.3 per cent interest on the capitalization of the company in stocks and bonds or less than 2 per cent on the bonds, which were issued as 5 per cent bonds. It is claimed that the reduction in cost of making gas with the new coke ovens will enable the company to pay the interest on its bonds and any increase in business will then serve to pay dividends on stock unless depreciation, extensions and the like eat up the profits. It seems to be the general opinion that the capitalization of the company, $4,833,000 bonds and $2,000,000 stock is materially greater than the investment in the plant with due allowance for depreciation and obsolescence.

Certain citizens of Indianapolis at the instigation of certain officials of the Citizens Gas Co., have obtained control of the Indianapolis Gas Co. with the purpose of leasing its plant to the Citizens company and make estimates of savings in the combination which will enable the Citizens company to pay 5 per cent on the bonds and 6 to 8 per cent on the stock of the Indianapolis company. They have come before the Indiana State Railroad Commission in its new capacity as a public utilities commission, to obtain authority for the combination. This has been refused upon the terms proposed.

The Citizens Gas Company is operating under a charter which is a most successful substitute for municipal ownership and protects the city and the gas consumers from the manipulations of officers or stockholders. It guarantees low gas rates and promotes the reduction of rates at the same time that it grants ample return on capital, a maximum of 10 per cent cumulative. The low rates are possible only because the company is operating on a cash basis and its capitalization represents no water and a minimum of promotion expense. The proposed lease of the Indianapolis Company's plant puts the present control of the operations of the Citizens company in jeopardy, for it provides that the Citizens company shall guarantee certain returns upon the stocks and bonds of the Indianapolis company. If the estimated profits of the combined plants do not materialize or if the management, either ignorantly or purposely, reduces the profits of operation of the combined plants until the minimum guaranteed return on the Indianapolis company's securities can not be earned, then that company can foreclose and obtain possession of the plant. Obviously, such a contingency must be guarded against, even if large profits appear to be in sight by ignoring this danger.

QUESTION DEPARTMENT

Sewage and Garbage Disposal Methods

Can you give me information regarding the Hopcroft-Mattack process of sewage and garbage disposal on which the Sewerage and Garbage Power Company of Boston and Chicago are said to hold patents?

SUBSCRIBER.

The Hopcroft and the Matlack patents are on gas producers and details of construction thereof and they may be available with garbage and refuse as fuel. The writer knows of no installation of a plant using garbage or refuse, and letters to the company referred to, addressed to Chicago and Boston were returned for better address. Have our readers any information they can give?

Underground Receptacles for Street Refuse

The city of Chicago has just appointed a committee to investigate street cleaning methods in various cities. A suggestion is made of a street sweeping receptacle which is to be buried in the ground instead of having the cans on the sidewalks as is now the case in the loop district.

What kind of sweeping receptacles are used by some of the larger cities of this country and Europe?

D., Chicago, Ill.

An illustrated article in MUNICIPAL ENGINEERING, vol. xlii, p. 445a, shows the method of construction and operation of such removable receptacles for street sweepings and street washings.

Segregation of Races by City Ordinance

Our city is interested in the division of the races into separate blocks, white and colored, under the recent Baltimore plan.

As a subscriber to your paper and as one interested in these matters, I would be very glad to have such information as you posses about the progress of this character of municipal legislation and what the ruling is thereon by the courts in the places where same has been tested.

M., City Attorney.

This question is referred to our readers. Are there any valid ordinances such as are described? It would seem that such ordinances must be operative only by general consent, unless, possibly, they could be put in form to be classed with the ordinances and statutes segregating races in street cars and railroad trains.

Where consent is general the segregation can be carried out without ordinances. It is perhaps easier to exclude colored persons from a territory entirely than to confine their residences to a definite area within the city. At any rate, certain cities and at least one whole county in Indiana are successful in preventing the settlement of colored persons within their limits, and have no ordinances or laws on the subject.

Results of Municipal Ownership of Public Utilities

I note a very interesting article in your issue of April, 1913, entitled "Failure and Success in Municipal Ownership," and it was particularly interesting to me as this borough, of which I am mayor, is seriously considering the advisability of putting in a municipal water and lighting plant. We have retained an engineer to lay out the plans and we expect his final report in the course of the next few weeks. In his preliminary report he states that it is entirely feasible and that the total cost would be in the neighborhood of $75,000. His plan is to sink wells and pump the water to a high point in the borough with a gas producer engine, which engine will at the same time generate sufficient electricity for street lighting as well as for private consumption. We anticipate a revenue of about $13,000 per year from all sources and we expect the costs and running expenses will be about $7,000 per year. This includes interest on bonds.

This is a small community of about 2,000 people actually living in the borough, but we have some 3,000 more living on the immediate outskirts who do all their trading in this town and most of them live nearer the heart of the borough, as far as distance goes, than do some who live in the outlying districts of the borough. However, we are figuring on putting the water mains and lighting only within our own confines and the above figure is to include some seven and a half miles of water mains and about ten miles of electric light.

While this council is very enthusiastic over the proposition there are many people in the borough who are objecting to it. It is not as though we could give a franchise for this light and water to any private company as there is none near enough to us to warrant their coming over and there seems to be no hope of any local capital coming into the field for this particular venture. My object in writing you is to find out whether there is any book of statistics published as to how many municipally owned plants there are in this country, both as to water, gas and electric light. If you know of such a book will you kindly advise me where I can purchase it or if not, will you kindly put me in touch with some one who may possibly give me this information.

Before this plant can become a fact the bonds must be voted for by the people and some of them, as above stated, are very dubious over the success of the enterprise, and I would like to give them some facts that would show that this is not an entirely new project and that it has been proved successful or otherwise in other communities.

H., Mayor, ———, N. J.

Other recent articles of interest in such cases are "Municipal Lighting Plant Operated by Oil Engine," being a description of the plant at Camden, N. Y., on p. 311 of the April number; "Municipal Plants in Small Towns," giving data about several small Kansas water and light plants, p. 371; "Eugene, Ore., Municipal Light and Water Plant," in May number, p. 427; "Pasadena Municipal Lighting Plant," showing nature of misrepresentations concerning results of municipal ownership and operation, in June number, p. 505; "Water Works of Daytona, Fla.," p. 550; "Selling Water at a Profit," a description of the Sylvan Grove (Kans.) water and light plant, p. 580.

The best list of municipally owned plants is that contained in the Municipal Year Book ($1.50), which was published some eight or ten years ago. It gives the facts concerning such matters in nearly all the cities and towns in the country as they existed at that time.

Transfers Between San Francisco's Municipal and Corporation Street Railways

Please find herewith copy of San Francisco compromise with United Railroad Co.

The option, regarding the right of the city to stop exchanging transfers after having commenced to exchange them, is a very serious one. Will you kindly give your interprettion of this?

As trust magnates play the same game from city to city, this point is liable to come up in any other city and when it means the life or death of a municipal railway, it certainly deserves consideration.

1. Note Clause 7, first line states, "Transfers shall be exchanged;" also read Clause 7, paragraph c. If the United Railroad Co. abuse their privilege or misuse their transfers in dealing with the city line, does the city give up the right to correct the United Railroad Co., except by mutual agreement," at the points mentioned along the municipal line? Note the words in Clause 7, paragraph f, "at other points"; also Clause 12, the last seven words, "except as in this agreement set forth."

2. Clause 7, paragraph d, note the words "the right is exercised by the city." If the city exchanges transfers, does the city "exercise the right" and will it have to continue to exchange transfers until January 1, 1917, or, could the city exchange transfers up to the opening of the world's fair and then stop? See next paragraph e.

3. If the city can not refuse to exchange transfers, would the city be liable for damages if it failed to take care of all of the transfer passengers delivered to the municipal line? This is the most important point in the agreement and means the life or death of the municipal railway, as the United Railway Co. may be able to deliver passengers from thirty car lines to this one city line.

The United Railroad Co. could claim they gave the municipal line the right to run down Market street so as to have an outlet for their passengers to the fair, and the city must continue to accept transfer passengers. If many passengers, going to the fair, had to take the state railway, boats and auto buses on account of the Municipal Geary Line not being able to handle the traffic sent to it by the United Railroad Co., could the U. R. Co. claim damages for loss of tranffic and justify the claim?

Could the U. R. Co. put on auto buses to carry the transfer passengers and charge the expense to the city, after crediting the city with the two-cent fare?

A man bought an option on a piece of property, for a nominal sum, for six months; a month later he grew afraid the man would want to back out, so he paid a hundred dollars on the property; when the six months transpired he decided to lose the hundred dollars and not take the property. The court ruled he had used his privilege by this act, he had "exercised the right," and was obliged to take the property upon the terms in the option.

A man may contract to build a house in six months and reserve the right not to build it. If he starts the foundation or does any work toward it at all, he has exercised his right and must finish the contract.

Paragraphs d and e in Clause 7 are a direct contradiction to each other, also it would make a one-sided arrangement, which the law of contracts does not permit. Can the city stop exchanging transfers after having started to exchange them?

4. Would a car labeled "Valencia Street" running on Market be a Market street line?

G. H. M., San Francisco, Cal.

The paragraphs in the compromise above referred to read as follows:

7. a. Transfers shall be exchanged by the United Railroads of San Francisco and the City and County of San Francisco, at the intersection of Geary street with Divisadero street, between the Divisadero street lines of the United Railroads of San Francisco and the line of the Municipal Railway on Geary street. Transfers issued for this point of intersection, however, shall not be honored by either party to this agreement unless presented by passengers boarding the cars at this point. Transfers shall be exchanged by the above named parties at the interseetion of Geary street with Fillmore street, between the Fillmore street lines of the United Railroads of San Francisco and the said line of the Municipal Railway. Transfers issued for this point of intersection, however, shall not be honored by either party to this agreement unless presented by passengers boarding the cars at this point. There shall be no compensation from any party to the other for the honoring of transfers at the intersection of the Municipal Railway with the lines of the United Railroads of San Francisco at Divisadero and Fillmore streets,

except the reciprocal privilege of transferring passengers. Transfers shall also be exchanged, should the city so elect, by the above mentioned parties at the following places and upon the following terms, namely:

b. At the intersection of Geary street with Larkin street, between the Larkin street line of the United Railroads of San Francisco, and the said line of the Municipal Railway. Transfers issued for this point of intersection, however, shall not be honored by either of the above named parties, unless presented by passengers boarding the cars at this point of intersection and also at the intersection of Geary street with Kearney street, between the Kearney and Third street lines of United Railroads of San Francisco and the said line of the Municipal Railway. Transfers issued for this point of intersection, however, shall not be honored by either party to this agreement unless presented by passengers boarding the cars at this point of intersection. All transfers from the United Railroads of San Francisco collected at the intersection of the Municipal Railway and Kearney and Larkin street lines of the United Railroads of San Francisco by Municipal Railway on its said line shall be redeemed at the end of each month by United Railroads of San Francisco at the rate of two (2) cents each; all transfers from said Municipal Railway collected at the intersection of the Municipal Railway and the Kearney and Larkin street lines by United Railroads of San Francisco, on its Larkin and Kearney street lines, shall be redeemed at the end of each month by the city and county of San Francisco, at the rate of three (3) cents each.

c. Transfers shall be issued under such traffic rules and regulations as shall be mutually agreed upon by the parties hereto, to prevent the misuse and abuse of the privilege.

d. The right, if exercised by the city, to exchange transfers at Kearney and Larkin streets, shall continue from whatever date the city elects until January 1, 1917, when further transfer arrangements may be made upon such terms and conditions as may be mutually agreed upon between the parties hereto.

e. The said city and county of San Francisco shall have the right, at any time, to abrogate this transfer arrangement, as to all of said intersecting lines, or any of them.

f. The provisions of this paragraph are and shall be without prejudice to any right which the city and county of San Francisco has, or may hereafter have, under the constitution and laws of the state of California, and the charter and ordinances of the city and county of San Francisco, to require exchange of transfers at other points along the line of the Municipal Railway.

g. The transfer privileges herein granted shall not be extended to permit transfers from Market street lines of the United Railroads to Municipal Railway, or to permit transfers from Municipal Railway to Market street lines of United Railroads, nor shall passengers boarding a Municipal Railway car on Market street going west transfer on the Kearney street line of United Railroads of San Francisco, unless the parties hereto subsequently agree thereto.

12. This agreement is and shall be without prejudice to any right which the city and county of San Francisco has, or may hereafter have, under the constitution and laws of the state of California, and the charter of the city and county of San Francisco to regulate street railroads, tracks and cars and the management, maintenance and operation thereof, and without prejudice to any of its rights under ordinances of the board of supervisors heretofore or hereafter adopted, all of which rights are expressly reserved by said city and county; it being understood and agreed that neither the Sutter Street Railway Company nor the United Railroads of San Francisco, by consenting to this provision, shall be deemed to have waived any of its rights, except as in this agreement set forth.

These questions can be settled definitely only by the court of last resort. They are mainly legal questions and so a lawyer's opinion would be the most valuable. But there are certain common-sense principles which may be applied and will give some indication of the probable nature of ultimate legal decisions, for good law is common sense and the unassailable court decisions are based on common sense.

1. Paragraphs a, c and e must be construed together, paragraph e evidently giving the city the right to abrogate the transfer arrangements at any or all of the intersecting lines at any time. The misuse or abuse of the transfer privilege referred to is doubtless that by the transferred passenger, but if the street railway company should abuse the privilege the city could require adequate rules and regulations under paragraph c or could apply paragraph e.

2. Altho paragraph e follows paragraph d, common sense would indicate that if the city elects to make the Kearny and Larkin street transfers it is bound to continue the same until January 1, 1917. This is apparently intended to prevent a failure of the city to continue the arrangement thru the time of the exposition in case it agrees to it and so prevents the street railway company making some other arrangement.

3. Kearny and Larkin streets are the only streets to which the requirement of continuous transfer service until January 1, 1917, if once established, are made to apply, and Divisadero and Fillmore streets are the only other crossings at which transfers are required. Market street lines are definitely excepted from transfer privileges to and from the municipal Geary street line. If the city cannot operate an exposition trunk line well enough to serve its own traffic and that from four cross lines, it deserves to be charged with damages whether the courts would assess them or not. The two crossings farthest down town, viz., Larkin and Kearny are subject to the division of all fares, and on the other two the city line retains all fares collected on its line, including the people returning from the exposition, and carries free only those going west from Divisadero and Fillmore street crossings. These two are not subject to the definite time limit of January 1, 1917, and could be cut off at any time under paragraph e if they endangered the safety of the line or the street railway company abused its privileges on any of

the transfers. The time limit of Kearny and Larkin street transfer privileges may not be one-sided on account of inability of the company to replace the service if withdrawn by the city after an agreement had been made to continue it. The writer is not sufficiently familiar with the local situation to be competent to express an opinion on this.

4. Many lines of cars run on a trunk line of railway which may or may not bear the name of the street on which the trunk line is located. They are all classed as belonging to that line. Thus a number of lines run on Virginia avenue in Indianapolis, none of which bear that name, but transfers are given marked Virginia avenue and are good on any line so far as it runs on that avenue. At one time there was a rule that the passenger must get off the car before it left the avenue which was punched on his transfer, but this rule has been practically impossible to enforce. If the Valencia car line runs down town on the Market street trunk line it is called a Market street line, whether the courts would term it technically a Market street car or not. Paragraph g applies to Market street lines, and is not restricted to Market street cars.

Standards for Loss of Paving Brick in Abrasion Test

What reason might be assigned for the new brick rattler being a more severe test (as I understand it is) on any given make of block, in comparison with the older style rattler with the cubical shot?

Also, have there been, as yet, any percentages of loss fixed for brick of the "brick size," or do you know of any municipalities that have fixed standards of their own in regard to this point, and what percentage of loss has been fixed?

HARRY F. HARRIS,
Assistant Engineer of Streets, Trenton, N. J.

The experts were somewhat surprised to find that the new brick rattler gave a more severe test than the older style. But the results are so much more nearly uniform that they feel that the new rattler is much better altho more severe. The limits of the percentage of abrasion loss have been increased to correspond and the latest specifications call for 22 per cent. maximum loss for the best qualities of brick. A note to the specifications adopted by the American Society of Municipal Improvements provides that with medium or light traffic the engineer may specify brick which will have a maximum loss of 25 per cent. or even 28 per cent. This specification provides for a brick 2½ by 4 by 8½ or a block 3½ by 4 by 8½, and no difference is made between the two sizes in the description of the test. It is probable that the effect of the test upon the brick size will be a little more than on the block size because the bricks would occupy less space in the rattler in proportion to the steel spheres than the blocks would.

Several cities have adopted the specifications with percentage somewhere between 22 per cent. and 25 per cent. for blocks, but with no distinction for smaller sizes.

Can our readers give any additional information?

Methods of Numuerbing Lots in Plats

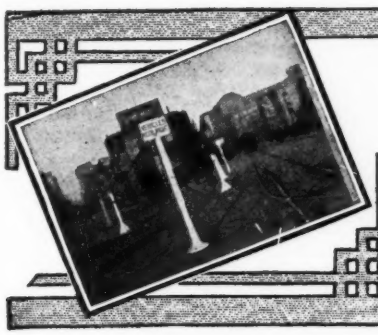
St. Louis, Mo., has the city block numbering system, where a city block, bounded by three or more streets is consecutively numbered, as the subdivisions are filed for record.

Do you know of any other city in the United States where the same or a similar system is in use?

FRANK PRESCOTT.

In Indianapolis, it is required that each addition to the city be approved by the County Commissioners if outside the city limits and by the Board of Public Works of inside or within four miles of the city limits. Each person who plats an addition uses his own method of numbering the lots. A very common method is to give each block surrounded by four streets a number, making these consecutive as nearly as possible. Each lot in a single block is given a number in a similar way so that lots are described by block number and by lot number within the block; Lot No. 8 in Block No. 2 of Jackson Park Addition, for example.

A recent paper before the Municipal Engineers of the city of New York gives a history of the taxation of real estate and the tax maps of the city. It shows that the assessors have at different times used different methods of numbering lots for their purposes, and that these numbers did not correspond with the lot numbers on filed property maps. Some hundred years ago the assessors numbered all the lots in a ward consecutively and the property owners filing the plats sometimes numbered the lots in the blocks separately and sometimes ran the numbers of the lots consecutively thru the entire plat in much the same ways that they are numbered in different plats filed in Indianapolis. About 1849 the tax numbering system was changed and the assessors' numbers were applied to each block separately so that each block was numbered independently of any other. This, of course, is simply a matter of convenience for the assessor and has nothing to do with the assignment of lot numbers by which to make transfers of the property. The system of numbering or lettering blocks and then numbering the lots in each block separately is the most convenient and also the most popular.



WORKERS IN THE FIELD

Rapid Concrete Bridge Construction

The Editor of MUNICIPAL ENGINEERING:

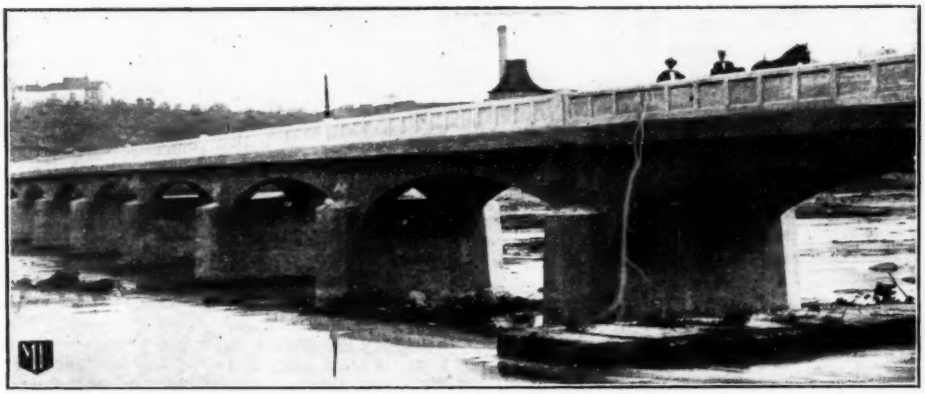
Sir—The Union street bridge at Danville, Va., is 1,060 feet long, 22-foot roadway. It contains about 160 tons of steel, round bars, and 3,000 cubic yards of concrete. The foundations are on solid rock and all shallow, as river currents prevented any dirt from lodging.

The design was furnished by Wilbur J. Watson, Cleveland, Ohio, and two ribs carry the floor system which is 14 inches thick without paving, that to be put on whenever the concrete floor wears enough to warrant it.

There was an old wooden bridge there and that was torn out as the new one was built, tearing out one span at a time and using the old bridge to carry the concrete to the new span, and using the old timbers for false work to hold up the concrete. There are thirteen 80-foot arches. The third arch was 90 per cent. complete when a defective timber in the bracing gave way and the span fell into the river. Despite that the structure was finished sixty-five days ahead of contract time and opened to traffic thirty-five days ahead, as forms had to stay in thirty days.

The old bridge was quite an advantage in the construction, and a dry summer was another advantage. Work was carried on night and day. A Ransome ½-yard mixer, two side dump cars and two mules included all the plant used.

Stone was shipped twenty miles; sand was taken from the river nearby; Old Dominion cement used; steel was furnished by the Carnegie Steel Co.



REINFORCED CONCRETE BRIDGE *on Union Street, Danville, Va.*

Danville is the largest loose-leaf tobacco market in the country, and a large part of the tobacco comes in by wagon over this bridge, and it was very important to get the structure finished between seasons. That result was easily accomplished, the construction requiring a little less than four months.

There have been two floods since completion of the bridge, one seventeen feet and the other fourteen feet, coming to those heights in less than ten hours.

THOMAS SHEAHAN, Contractor,
Richmond, Va.

Mr. Sheahan is a contractor of large experience, having completed seventy-two concrete structures and is evidently able to do good work at a rapid rate.

Economy of Pumping with Gasoline Diaphragm Pump

The Editor of MUNICIPAL ENGINEERING:

Sir—My information regarding diaphragm pumping engines is the result of observation and record made while resident engineer of the system of sewers and disposal plant at Franklinville, N. Y., during 1911-12.

Shortly after the trenching for the outlet sewer was started it was found that the ground water at a depth of from four to six feet flowed in such volume that hand diaphragm pumping would be very expensive and almost impossible. At my suggestion the contractor purchased a gasoline diaphragm pumping outfit from the Harold L. Bond Co., of Boston, Mass. It consisted of one gasoline engine, 3½-inch bore and 3½-inch stroke, water cooled, and connected "T"; one No. 4 Edson diaphragm pump with 20 feet of 4-inch suction hose and strainer complete, on truck.

Upon the arrival of this pump there were nine men operating three No. 3 Gould diaphragm pumps by hand, and they could just handle the flow of water if they could keep up hard pumping. This was accomplished by changing the men from time to time from the trench to the pumps.

Upon starting the Bond pump it was seen at once that the stroke of the pump was not right and it did not pump its capacity. This was remedied and the pump took care of all the water, relieving the hand pumping at once.

This pump was operated almost continuously for eight months and with repairs amounting to less than $5, not including new diaphragms. These repairs were due to two causes, one the neglect of the operator to keep the parts properly tightened, and the other the fact that the engine and connections were a little light weight for that size pump (No. 4). I understand these people now make a heavier type of engine for No. 4 pumps.

The average cost of operation was as follows, 8-hour days:

1 gal. gasoline	$0.20
1 pint oil	.15
Batteries	.15
Total	$0.50

The cost of operating the three No. 3 pumps by hand was as follows:

Nine men at $1.60 for eight hours, the wages paid at that time, amounts to $14.40, making a difference of $13.90.

This was the actual comparison as noted the day the pump was started.

I have allowed nothing for depreciation, since that would be only slightly more on the gasoline pump than on the pump operated by hand, as it would be impossible for one pump to be operated by hand continuously and handle the amount of water this gasoline pump would handle. I do not believe the number of diaphragms used would be in excess of the number required for hand pumps.

The maker of this pumping engine claims it to be "fool-proof," and he is right; it is very simple and very easily operated. It never failed to operate and do its work when given the proper care that any machine requires.

It was left at the end of a 6-inch underdrain to pump all day with no one near it except to put in oil and gasoline once or twice a day.

The contractor purchased another pumping engine later, and this was a domestic engine made in Pennsylvania. It was connected to a No. 4 diaphragm pump and was some heavier in build than the Bond engine. Its cost of operating was about the same as the Bond engine, and it did as much pumping when it worked, but the ignition and timing devices were more complicated and gave much trouble. This uncertainty of operation caused this engine to become a secondary consideration when a pump was wanted on this work. It did some valuable work, and were its operation more positive and simple, no fault could be found with it.

The one annoying feature common to both pumps was the exhausting of the batteries at a time when the pump was needed, and it seems as if this might be overcome by a magneto properly attached and housed for protection. There is no question in my mind any longer about the advantage of pumping with power-driven diaphragm pump over hand operated pumps, no matter what the quantity of water may be. And no contractor can afford to pump by hand at the present price of labor when the amount of water to be pumped begins to approach the capacity of a No. 3 diaphragm operated by one man only.

C. R. ANTHONY, C. E.,
Rochester, N. Y.

Service Tests of Oil Engine

The Editor of MUNICIPAL ENGINEERING:

Sir—We installed a 225-h.p. Diesel oil engine, direct connected to a 200-k.v.a. Fort Wayne a.c. generator, in November, 1911. We have operated this unit continuously since that time. We have never had a shutdown or an interruption of service in that time from any fault of the engine. The regulation is good, being within the guarantee of 35 per cent. at all times. Our load varies from 25 to 250 h.p.

Owing to the fact that we operate a steam unit, and thru a part of the time over peak parallel same with the oil engine, we cannot give an accurate record of the fuel cost on the Diesel alone for the straight period. During such times as we operated it alone, the fuel cost ranged from 1½ to 2½ mills per k.w., the price of oil ranging from $1.17 per barrel of 42 gallons to $1.80 per barrel. The steam unit is a 150-h.p. Ball four-valve engine, belted to a 100-k.v.a. generator.

For the year ending October 31, 1911, our total fuel bill on the steam-operated plant was $6,364 against a gross revenue of $23,000. For the year ending October 31, 1912, our total fuel bill, including the coal used on steam unit, for what time it had to run with the Diesel, was $3,528 against a gross revenue of $27,200. We had no record of the total k.w. output for 1911, hence could not make a comparison on that basis; but the increase for 1912 was considerable, with a reduction in rates, also.

Our total repair cost on the Diesel engine from November, 1911, to date, is $158.33, the major portion of this being for a set of exhaust manifolds put in lately, the first set being eaten out by the action of the circulating water and sulphur in the fuel.

This unit is shut down only once a week, on Sundays, for about three to four hours, and is never shut down thru the week.

I enclose a copy of a test made for us on this engine by A. C. Scott Engineering Co., of Dallas, last season.

J. H. DAWLEY,
Mgr. Hugo Ice and Light Co.,
Hugo, Okla.

The summary of the results of six tests with various loads is given in the following table.

SUMMARY OF TESTS.

Number of Test	1	2	3	4	5	6
Date of Test	4-20-12	4-20-12	4-21-12	4-21-12	4-22-12	4-22-12
Duration of Test Hours	3.00	3.00	3.00	3.00	3.00	3.00
K.W. Switchboard Reading	.....	37.42	80.23	117.5	160	180.1
Comp. Motor, Gross K.W.	.....	6.9	9.09	8.93	10	11.4
Net K.W. Output	.....	30.52	71.14	108.75	150	168.7
Efficiency of Generator per ct.	.....	85	87	90	92	92.5
Net B.H.P. Load	2.25	49.7	111.39	162.97	219.63	245.6
Speed, R.P.M.	171.1	169.1	167.4	164.4	164.8	161.9
Lbs Cooling Water Per Hour	3187	3037	4875	6300	4537	5175
Jacket Inlet Temp. F. deg.	61.8	62.4	61.9	62.6	61.7	66.7
Jacket Outlet Tem. F. deg.	115.3	127.9	115.5	118.9	156.6	173.1
Injection Air Pressure—Atmospheres	39	45.6	56	59	66	77
Fuel Oil—Pounds Per Net K.W. Hour	.....	1.25	0.7555	0.681	0.646	0.644
Fuel Oil—Pounds Per Net B.H.P. Hour	.....	0.769	0.482	0.454	0.441	0.444
Fuel Oil—Gals. Per 100 Net B.H.P. Hour	.....	10.8	6.8	6.4	6.2	6.2
Thermo-dynamic Efficiency (based upon net useful output, per cent	.....	17.4	27.8	29.5	30.3	30.2

Gas and Electric Light Rates in Large Cities

The Editor of MUNICIPAL ENGINEERING:

Sir—The city of Birmingham, in proceeding for lower gas rates, has collected some interesting statistics, copy of which I enclose.

ROMAINE BOYD, City Attorney,
Birmingham, Ala.

Name.	Electric Lights. Max. Price per k.w. hr.	Steam or Water Power.	Gas. Max. Price per 1,000 ft.
Birmingham	$0.09	Steam	$1.00
Worcester	.10	Steam	.76
Fall River	.09½	Steam	.80
Oakland	.07	S. & W.	.90
Memphis	.10	Steam	1.00
Atlanta	.07	Water	1.00
Richmond	.10	S. & W.	.90
Washington	.10	Steam	.85
Louisville	.07½	Steam	.72
Omaha	.13	Steam	1.15
Des Moines	.12	Steam	.90
Kansas City	.10	Steam	.27
New Orleans	.13	Steam	1.10
Paterson	.10	Steam	.90
Denver	.08	Water	.85
Los Angeles	.06½	S. & W.	.75
St. Paul	.11	S. & W.	.95
Scranton	.09	Steam	.95

Note—Above prices are net. All plants privately owned except the gas plant at Richmond. Prices for electric lights in nearly all of these cities subject to large reductions for monthly consumption exceeding about 30 k.w. hours. All gas is manufactured except at Kansas City, which has natural gas.

To this list may be added Indianapolis,

in which two private companies are supplying gas at 60 cents, one of them paying 7 per cent. dividends and the other not paying full interest on its bonded indebtedness. The steel business in and around Birmingham seems to promise a market for coke which would make the Indianapolis plan successful for that city.

Asphaltic or Bituminous Concrete Pavements

In the article with the above title on page 334 of the April number of MUNICIPAL ENGINEERING is a table giving detailed estimates of the cost of asphaltic pavements of various mixtures, in which two or three obvious errors appear. In the make-up the headings of the two columns, "Binder Course" and "Straight Sand," were transposed as well as the order of the words. The cost of fuel at the plant in the column headed (wrongly) "Binder Course" is given as $0.044, when it should be $0.004, the same as the other mixtures, except that in the last column, which is the figure for binder course. The depth of grading for bitulithic pavement in the note marked ‡ should be 8 inches, the same as for stone-filled asphaltic wearing surface. These errors are due in part to the printed copy from which the table was taken and in part to the make-up after the material had left the editor's desk.

In a communication to *Engineering Record* criticising the original estimates presented by C. A. Mullen, the superintendent of public works at Schenectady, N. Y., from which the table referred to above was taken, George C. Warren presents some points in which he differs from Mr. Mullen. One is due to the typographical error in the table giving cost of fuel, above corrected. Mr. Warren's other objections are briefly as follows:

The 0.1 cent per square yard allowed for plant repairs on the 15,000 square yards laid per month with a $25,000 plant would aggregate only $15 a month, which is "ridiculously small."

Tools and sundries at plant and on the street at 1 cent per square yard would amount to $150 a month each, which are also considered ridiculously low, as well as the rates paid labor as compared with those paid now.

Team labor at 2.1 cents a square yard is equal to 21 cents a ton, which, with team labor at $6 to $7 per 8-hour day with loading and unloading and waiting time accounted for, is again considered too small.

Asphalt cement for painting gutters is charged at 0.1 cent a square yard of pavement for all kinds altho bitulithic gutters are not so painted, but a flush coat of asphalt cement and stone chips is applied the entire width of the pavement. Mr. Warren considers the estimate for painting asphalt gutters too low, and would add for a 50-foot width of bitulithic enough to make the cost of the asphalt cement 3.3 cents per square yard, with an addition of at least 5 cents for hot stone chips, labor and fuel, making the total cost about 8.5 cents for bitulithic instead of 0.1 cent.

The five-year guaranty bond at 5 cents more than covers the surety company's premium, but does not cover reserves for contingent liabilities under the guaranty.

Supervision, management and office charges at 7 cents a square yard amount to, say, $1,050 a month, or 2 per cent. of the value of the business done, which is stated to be very much less than the necessary overhead expense in any well-organized contracting business.

Grading per square yard at 7 cents is about one-third the actual average cost.

Concrete per square yard, 6 inches thick, 1-3-6 proportions, is given at 55 cents a square yard, or $3.30 a cubic yard, very much less than is possible under present prices of labor and materials.

The estimates allow nothing for such items as interest on invested capital, premiums for liability insurance and workmen's compensation, and allow but 10 per cent. for profit, or 11 cents a square yard, which is stated by Mr. Warren as the customary allowance by contractors for unforeseen contingencies before the profits are computed.

Milwaukee papers have been reporting the failure of the "stone-filled" asphalt pavements on North avenue, Vliet and Walnut streets, laid in winter weather late in 1911, as evidence of the failure of cheap asphalt paving. Mr. Mullen, who laid the stone-filled asphalt pavements in Milwaukee under similar specifications to those in use by him in Schenectady, points out that the three streets named and one or two others were delayed by bad weather, and, being business streets, had to be completed at once, and were laid in temperatures mainly between 0 and 32 degrees Fahr. Much of the concrete froze and oil burners were used in an attempt to thaw out and dry the surface of the concrete before laying the asphaltic layer. He points to the condition of pavements laid in good weather under the same specifications, such as Cambridge avenue, Greenfield avenue, two miles long, Twenty-seventh, Galena, Germania and many other streets, as evidence of the success of the method of asphalt paving used by him, and that the failures reported are really due to the unusually bad weather conditions during the construction of those pavements.

Wood Block Pavements in Chicago

The Editor of MUNICIPAL ENGINEERING:

Sir—Wood block pavements, in which the blocks are treated with a preservative to prevent decay and exclude moisture, are a development of recent years. The first preservatives used were chemicals, but it soon became apparent that while there were several chemicals which were very good fungicides there were none which of themselves would withstand the leaching effect of moisture. Attention was then directed to the use of the dead oil of coal tar or creosote. The satisfactory results which have followed the treatment of wood paving blocks with creosote are too well known to bear repetition. It is sufficient to say that the creosoted wood block is now the competitor of every other form of paving material.

In the business districts of our large cities, where the elimination of noise is so desirable, and at the same time without sacrificing the permanency of the paving material, creosoted wood block has a large sphere of usefulness and is rapidly replacing all other forms of paving for streets with such conditions.

The principal qualities which recommend a wood block pavement are: It is smooth, sanitary to a high degree, noiseless, durable, low in tractive resistance, comparatively low in first cost, low in the cost of maintenance and easy to repair. The principal objections which are urged against the wood block pavement are that under certain conditions it is slippery, that it exudes during the first season an objectionable oil from its surface which is tracked into homes and offices, and that the pavement often absorbs water and expands to such an extent that in places it will blow up or explode. These objections will be considered in order. It is often claimed by those supporting some other form of pavement that the wood block pavement is dangerous because it offers no foothold to horses when wet in summer or when covered with ice in winter. It is our experience that when a wood block pavement is kept reasonably clean, as all pavements should be maintained, it is no more slippery than any other form of pavement with an equally smooth surface. It is only when the pavement is allowed to become dirty that street sprinkling or falling rain produces a thin coating of slime or mud which is dangerous. Slipperiness on wood block pavements is much more dangerous in winter than in summer and more difficult to prevent. It is the result of the formation of a thin coating of ice upon the surface of the pavement. This condition of the surface is usually caused by the snow not being promptly removed, a portion of it melting and forming a coating of ice. A rapid removal of the snow will largely prevent this condition. When a pavement becomes icy in spite of all reasonable precautions, the slipperiness may be greatly remedied by sprinkling the surface with coarse torpedo sand or ashes. In many European cities grit or finely crushed stone in sizes from the smallest up to the size of a pea is employed for this purpose with success.

The true cause of bleeding or the exudation of oil from the wood blocks during the first season does not seem to be generally agreed upon. The theories upon the subject are many and various. It is contended by some that bleeding is due to the use of a large amount of heavy gravity oil (specific gravity 1.10-1.14, which is a mixture of creosote with pitch) instead of a smaller amount of light gravity oil (1.03-1.08 true creosote) formerly used. By some it is contended that the natural expansion of the block upon heating forces the oil from those pores in the surface which are filled to excess. By others it is contended that bleeding is the result of the process of treatment; hot steam being used to remove the sap, some moisture is inevitably imprisoned, and this moisture vaporizing when the blocks become heated forces out the excess of oil. It is noteworthy that whatever the true cause of bleeding, when the light gravity oil was used during the earliest years of the wood block industry bleeding, such as we know it today, was practically unknown. There is a present tendency to get back to the use of the lighter oil, and we believe this to be a step in the right direction which will do much towards solving the problem of bleeding. Bleeding in creosoted wood blocks seldom occurs after the first season. Its amount and extent cannot be accurately predicted. It may be confined to a few weeks, and again may continue for months, during hot weather. The usual method pursued to reduce the effects of bleeding is to cover the surface of the pavement with a thin coating of torpedo sand, which absorbs the oil. It has been suggested that, after bleeding had progressed until the surplus oil had been absorbed by the surface coating of sand it might be desirable to have the surface rolled with a light roller (about ten tons), in order to force the small pieces of stone and grit into the blocks, thus forming a sort of secondary wearing surface. However, if it becomes apparent that a first treatment is insufficient, a second and lighter coating of torpedo sand is applied. Before applying the second coating the first coat is often removed by scraping. This is a matter, however, to be decided by the engineer. When treating a wood block pavement with sand to reduce bleeding, the surface must be kept sprinkled to keep down the dust.

As to the troubles caused by expansion

in wood block pavements, we believe that they are preventable. The principle that the surface of the pavement must always be waterproof should be the guiding one in constructing a pavement of this kind. No filler for the joints which will permit water to reach the under surface of the blocks should ever be used. For this reason sand and cement grout fillers are objectionable. Pitch and asphaltic fillers are satisfactory. Ample expansion joints should be provided at the curb in general at least 1½ inches in width and for wide streets 2 inches. Transverse expansion joints are not necessary. They are a source of weakness.

The creosoted wood block varies in length from 5 to 10 inches, in width from 3 to 4 inches, and is generally 4 inches in depth. Several woods, such as southern yellow pine, Norway pine, black gum and tamarack, have been used, but the one which has given the most satisfactory service is southern yellow pine. There are two general methods of laying the block, perpendicular to the curb and at an angle varying from 45 to 67 degrees with the curb. Either method gives good results. The blocks are generally laid upon a cushion of sand one inch in thickness. For this purpose torpedo sand is to be preferred to ordinary building sand, since torpedo sand will hold its position and will not gradually work away from the crown of the pavement towards the curb. Again, should water reach the sand cushion it will drain away thru the coarser sand, while it will be retained by the fine sand. An improvement upon the use of sand alone as a cushion is to lay the blocks upon a dry mortar of cement and sand, which is sprinkled with water just before placing the blocks. When wood blocks are laid next to the car tracks in a street, this cushion of cement mortar should always be provided near the rail. The shoulder of the rail should be filled compactly with a somewhat rich mixture of cement mortar and the blocks should be laid flush with the top of the rail. It is well, also, to see that the blocks are laid upon a cushion of cement mortar next to all manhole covers in the street surface. The problem of maintaining a street pavement next to the rail of a street car track which is not laid upon a concrete foundation, is very difficult, and no permanent pavement should be attempted in any street in which the street car tracks have not been put in the best of condition. It is the duty of the inspector to see that no blocks with any defects, such as checks, unsound, loose, or hollow knots, knot holes, worm holes, thru shakes and round shakes that show on the surface are used in the work. In the southern yellow pine the annual rings measured radically from the center should average not less than eight to the inch. As a pavement which can be used under a wide range of conditions, the creosoted wood block is fast demonstrating its claims to superiority.

LOUIS A. DUMOND,
Engr. of Com. on Downtown Streets,
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Track Elevation in Indianapolis

The Board of Public Works of Indianapolis, Ind., has entered into a contract with the Union Railway Company for the elevation of the main tracks thru the central portion of the city and the train sheds at the Union Station, which covers a large part of the work included in the track elevation resolutions passed by the board in 1912. This elevation will necessitate the elevation of certain freight depots and yards included in the plan on which the resolutions were based, and contracts must be made with the various railroads interested to provide for the construction of these additions to the main work.

The contract with the Union Railway Company seems to be tentative, being contingent on the ability of the city to vacate certain streets and alleys which will be required, and of the company to acquire certain tracts of ground from the other railroad companies and others on which to locate additional tracks and facilities which are required. There is also a very definite expression of opinion by attorneys familiar with the former track elevation proceedings to the effect that the law will not permit the city to join in the payment for additional tracks for additional facilities for the railroads themselves, or for the laying of tracks upon the elevated areas when completed, all of which are provided for in the contract, to a greater or less extent. It is possible, therefore, that modifications in the contract must be made before it can be completed and that there will be some delay in beginning work. This would be unfortunate for the city has been working nearly twenty years for grade separation and is becoming impatient of further delays.

Repairs With Oxy-Acetylene Gas

One of the numerous ingenious applications of the oxy-acetylene gas flame is made at Dayton, O., in welding the lamp posts which were broken by the debris washed thru the streets by the Easter flood. Some 200 of the heavy cast-iron ornamental cluster light poles are reported to have been broken off. Many of them can be welded together in place by the portable apparatus, with the aid of a small derrick to set the pole back on the pedestal from which it was broken.

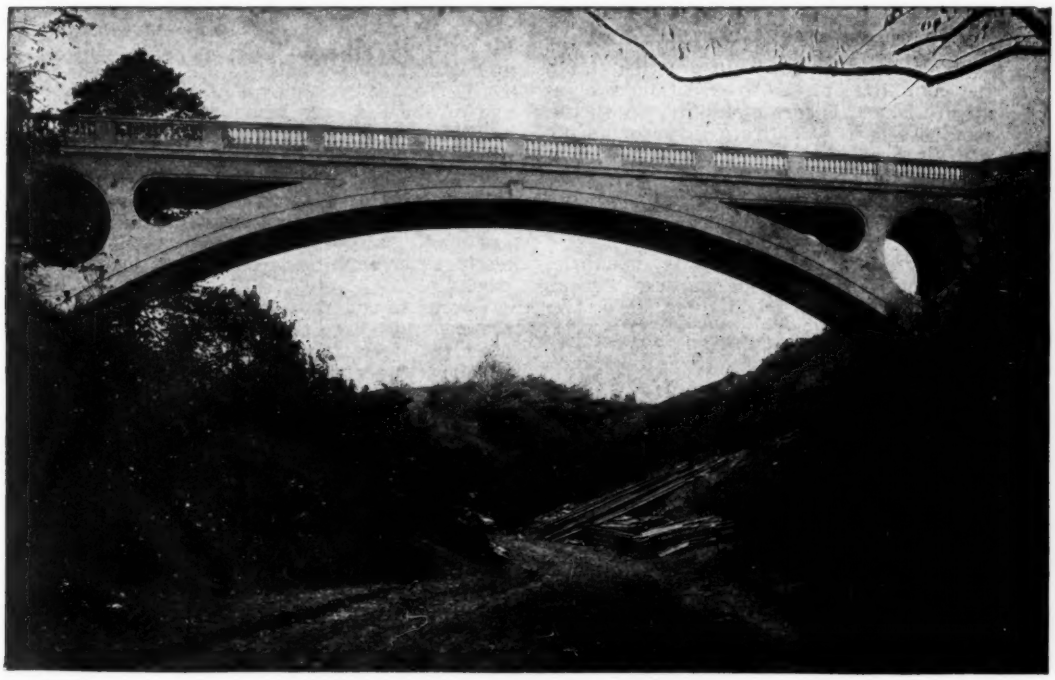
CONCRETE

Lake Park Bridge, Milwaukee, Wis.

By O. B. Young, Jr.

A bridge has recently been constructed over a gulley in Lake Park near Milwaukee, Wis., built entirely of concrete reinforced according to Kahn system of reinforcement. It is 216 feet long and 14 feet wide.

The abutments are 14 feet wide, 9 feet deep and run back into the earth 16 feet. They are constructed of concrete proportioned 1 part cement, 3½ parts sand and 7 parts stone and are reinforced with ½-inch round rods placed in the back and spaced 12 inches c. c.



LAKE PARK BRIDGE, *Milwaukee, Wis.*

The bridge approach is constructed with 12-inch walls. Running back from the face of the abutments 20 feet they are built in an octagon shape and from there they run back, parallel with each other, 28 feet. These walls are 12 feet apart and are brought up from the abutments to within 6 feet of the grade by a series of steps. The octagon walls rest upon footings 24 inches wide and the parallel walls upon footings 18 inches wide. On the tops of these walls is placed a solid concrete railing. Between these walls is placed an earth fill.

There is 118 feet between the face of the abutments, which is spanned over with two arch ribs with a spring of 18 feet. These ribs are 12 inches wide and have a depth of 5 feet at the crown. They are constructed of concrete proportioned 1 part cement, 2 parts sand and 3 parts stone and are reinforced with Kahn bars. The reinforcement carrying the bridge is 4 Kahn bars 1 by 3 inches made continuous and spliced with turnbuckles. Two of these bars are placed in the bottom of the ribs and two are inverted and follow the arch 4 feet 2 inches from the bars in the bottom. In order to make the bridge as light as possible, two openings have been placed in each of the deep parts of the ribs near the abutments. These openings are placed so that upper and lower beams are formed. The lower is the above mentioned beam; the upper beam is really four beams, one over each

opening. The beam over the opening nearer the crown is reinforced with two Kahn bars 1 by 3 inches and in the beam over the opening nearer the abutments, two Kahn bars ¾ by 2 inches are used. The ribs are stiffened by stout brackets 8 inches wide placed every 12 feet.

A floor designed to carry a live load of 75 pounds is placed over these ribs. This floor is a concrete slab 6 inches thick, proportioned 1 part cement, 2 parts sand and 4 parts stone, and is reinforced with ½ by 1½-inch Kahn bars, spanning on the arch ribs, spaced 9 inches c. c. The slab is tied together with ¼-inch round rods 18 inches c. c., running full length of the bridge. A concrete balustrade railing is placed at the outer edges of the bridge between the abutments.

This bridge has a very artistic appearance and was put up in less time and at a less cost than a steel bridge could possibly have been constructed for.

Cracks in Concrete

The reinforced concrete practice standing committee of the British Concrete Institute issued letters of inquiry to all the members of the institute in order to obtain information concerning cracks in concrete and received in reply some fifty-four letters, and presented the following at the institute's thirty-sixth general meeting:

The cracking of concrete is unsightly, but is not necessarily dangerous. Cracks in concrete may be divided into two classes:

1. Surface cracking.
2. Body cracking.

Surface Cracking

In the first category the cracks are often referred to as "hair" cracks, by reason of their fineness and semblance to hairs, and occur both in plain and reinforced concrete. They are also known as "crazing" and are of very frequent occurrence. They appear to arise from the surface skin of cement mortar being richer in cement than the mortar of the body concrete, thus exposing almost a neat cement skin, which expands at a different rate on exposure to the sun's rays than the body concrete. It is worse upon the uppermost face in a mold, where the lighter and weaker particles of cement work up to the top and form a skin known as "laitance." If work be kept under water, and sometimes, if shielded from the sun, this crazing may not occur. To overcome its unsightliness, the surface skin should be removed either (1) by brushing the concrete when green with wire brushes; (2) by rubbing by means of a stone or piece of concrete and sand and water; (3) by dressing with hand or pneumatic operated chisels and hammers; (4) by brushing the surface with hydrochloric acid and subsequent washing with clean water. The last two named methods are best with completely hardened concrete.

Body Cracking

The cracks extending through the body of concrete may be ascribed to the following:

1. Faulty design and construction so far as statical resistance is concerned.
2. Expansion of cement or concrete.
3. Corrosion of embedded steel.
4. Shrinkage from setting and hardening in air.
5. Difference of temperature in different parts.

Faulty Design and Construction

Under the first head the following causes have been noted:

(a) Settlement of the foundations.

(b) Too high a stress in the reinforcement, resulting in excessive deformation.

(c) Too thick a covering of concrete, in particular where the effective depth of beams is very small.

(d) Too early removal of forms. The age of the concrete when the forms are removed must be sufficient to give the usual factor of safety due to the stresses caused by dead load and such accidental load as may at that time be anticipated. Generally the following recommendations are made, subject to the approval of the engineer or architect responsible for the works.

For mass concrete walls not subject to thrust, and where the height does not exceed two feet, the forms should not be removed under twenty-four hours. Where the wall is subjected to pressure, forms should remain in place at least a week, altho a fortnight is preferable. For mass concrete arches of more than twenty-foot span one month is recommended.

For reinforced concrete the following is recommended:

Slabs, a minimum of seven days, but otherwise, for slabs carrying only their own weight, an allowance of two days per inch of thickness, or one day per foot of span, whichever is the greater. For sides of beams, walls and columns not under side-thrust, a minimum of four days; bottoms of beams, a minimum of two weeks, though a month to six weeks may be necessary under special circumstances; for arches the time of removal of the centering is better left to the judgment of the engineer, keeping in view the ratio of rise to span and special circumstances.

If it is intended that the structure should be used for the carrying heavy weights, emergency props should be left in for such time as the engineer or architect may direct.

The foregoing periods to be increased by at least the time during which frost or rain has intervened.

(e) Defective design of forms with inadequate allowance for contraction and expansion due to variation of moisture. Dry timber may expand and crack the concrete unless wet beforehand.

(f) Careless removal of forms, which may result in cracking the concrete by shock of falling timber, or by levering and prising on the green concrete.

(g) Vibration, resulting in deficient adhesion and excessive deflection. Forms should be very rigid.

(h) Insufficient allowance for continuity, fixity and general monolithic nature of concrete work done *in situ*. Over supports the maximum degree of continuity and fixity should be provided for. Frequently cracks will be found over supports of continuous reinforced concrete beams and floor slabs, owing to the omission or insufficiency of steel there. Concrete floors are often built in chases in walls and carried over walls, others standing above, and sufficient fixity is given to cause cracks, if provision has not been made in the reinforcing. Columns and piers when built monolithic with beams will give more or less fixity to end of beams resting thereon, both at end and intermediate supports.

(i) Too close spacing of steel, so that there is no room for the concrete to get round and adhere or bond with the bars.

Expansion of Cement or Concrete

Under this heading the following causes of cracking are noted:

(a) Overlimed and coarsely ground cements which were frequently met with years ago caused expansion, to overcome which it was necessary to leave room for expansion; i. e., expansion joints. Especially was this precaution adopted around the edges of floor slabs adjoining walls.

(b) Coarse materials containing sulphur compounds, unburned fuel, oxidizable or hydratable iron compounds, unslaked lime, and other deleterious substances. Breeze, clinker and slag frequently contain sulphur and metallic iron or oxide of iron, while boiler ashes may contain both sulphur and unslaked lime (the latter derived from limestone in the coal). Some bricks contain sulphides and sulphates and lime, and should not be used broken for concrete. Old bricks also sometimes have old plaster adhering to them; the sulphate of lime may cause no trouble in plain concrete while it is kept dry, but in the presence of water reacts chemically with the aluminates of the portland cement, forming sulphoaluminate of lime, which is attended by increase in volume, and may cause blowing if in large quantity, and even a small quantity may result in cracking. Free lime in the same way will swell or contract with water. Black magnetic oxide of iron will become converted into hydroxide of iron in the presence of moisture. Indeed, any iron compounds are dangerous in reinforced concrete as likely to react electrolytically with the steel in the presence of moist air or dampness, and sulphur causes speedy corrosion.

Corrosion of Embedded Steel

Should steel in reinforced concrete corrode by reason of porosity of the concrete or the presence of deleterious substances in the coarse materials of which it is made, or by electrolytic action, the concrete cover to the bars will crack and burst off.

Shrinkage From Setting and Hardening in Air

This is probably the most frequent cause of cracking.

Concrete will expand slightly in water and contract on drying out, so that cracking is frequently not evidenced from this cause until the concrete is allowed to dry, varying usually up to two months, and in thick mass walls moisture and heat are retained for a long period and may delay cracking up to six months and even longer. It is usual to keep concrete wet for several days after manufacture in order to insure its gaining maximum hardness, and it is especially important to prevent rapid drying by sun and wind, so that the surface of concrete should be shielded against such exposure. A dry mixture of concrete shrinks less than a wet mixture, and concretes richer in cement contract more than lean mixtures. For reinforced concrete work medium wet mixtures are desirable, and therefore concrete richer in cement than 1 to 5 is not advisable for curtain walls. The coefficient of contraction of concrete on exposure to air appears to be about 0.0002 to 0.0005 at one month, and increases to about 0.0004 to 0.0006 at 1½ years. The variation recorded is between poor and rich concretes. Such contraction is usually prevented from taking place uniformly thruout; in retaining walls and pavings it is prevented by friction of the soil, in other cases by the holding of other parts. Plain concrete will usually hold together for some distance, so that contraction joints need only be inserted at intervals. The following are advised as suitable distances apart of such joints in plain concrete:

Paving, 4 to 5 feet.

Curtain walls, 10 feet.

Exposed retaining walls, 15 to 20 feet.

Basement retaining walls (not exposed) and dock walls or dams, 50 feet.

If curtain walls adjoin heavy colmns and beams, the rigidity of the latter would probably result in cracking if constructed monolithically, even if reinforced. It is

best, therefore, in such cases to provide joints adjoining beams and columns.

If concrete be laid over the joints of a thicker lower surface of concrete, the joints of the latter will most probably be evidenced in the upper surface.

Sharp angles in structural members have little resistance, and should be avoided, as also irregular shapes. The angles of window openings, unless well rounded, should be reinforced by bars placed diagonally.

As the rate of shrinkage varies with different proportions of the concrete ingredients—cement, sand, coarse material and water—variation in such proportions should be avoided as much as possible. Cracks in plastering are often due to such irregular contraction.

Partition and wall blocks, if required to be plastered soon after laying, should be quite dry before laying. If erected wet, the plaster should not be applied until they have had good time to shrink, otherwise the joints of the blocks will show as cracks in the plaster.

Large surfaces have been successfully constructed without apparent cracks by properly reinforcing the concrete and laying all at one operation. The object of the reinforcement is to break down the tensile resistance of the concrete and cause it to crack uniformly at such close distances as to render the cracks invisible to the eye. If one portion of the concrete be left over night, great care should be taken to roughen the hardened surface by tooling away; then clean by brushing with water, and apply half an inch of mortar of the same proportion as the mortar in the concrete and ram the fresh concrete well against it. Such joints will often show, even though well reinforced. In calculating the amount of reinforcement for such purpose, the ultimate tensile strength of the concrete at one month should be equated to the resistance of the steel at the yield point. Usually for a 1:2:4 concrete ½ per cent. of steel is required each way, the bars or mesh work being laid at right angles. The reinforcement should be in small sections and well disseminated thru the thickness of concrete, and a layer of bars should be near each face. So-called "distribution bars" near the bottom of floor slabs are not sufficient if cracking is to be resisted; rods should also be placed near the upper surface. Cracks frequently occur parallel to rods where "distribution bars" are not used, and also occur at right angles to main bars where continuity bars stop. Top reinforcement would avoid this. Contraction reinforcement should be in addition to the section of steel required to resist static forces.

The sudden drying out when heating apparatus is installed frequently causes excessive cracking.

Difference of Temperature in Different Parts

Considerable difference of temperature will cause cracking and should be avoided as much as possible. Heavy reinforcement is not always an effectual preventive. Most reinforced concrete chimneys, in which the internal temperature is over 500 degrees F., seem to be cracked vertically, externally, and often horizontally as well, though possibly the latter could be avoided. This cracking is probably due to the difference in temperature between the outside and the inside, which may be considerable with a cold wind blowing. A continuous lining with cavity between it and the outer shell would probably prevent serious cracking.

Great difference in the temperature between the under side and top of concrete floors is also likely to cause serious cracking. In some climates the variation in temperature is extreme and cracks will result, and even if reinforcement is provided it will be well to insert expansion and contraction joints every fifty feet.

Concrete lining and walls of ponds, tanks and the like exposed to water do not shrink by setting and hardening of the concrete, but change of temperature between summer and winter will cause cracks unless joints are provided. If plain concrete, a joint every fifteen feet is desirable; if reinforced, joints might be fifty feet apart, though closer is preferable. To prevent percolation, asphalt dowels in the joints have proven efficient.

Concrete Bins of Norfolk Sand and Gravel Plant

The accompanying illustration shows the unique equipment of the gravel plant with separate concrete bins at Norfolk, Va., which has a 500-yard sand and gravel washing and screening equipment. This plant is a model of its kind and is perfectly equipped to produce the highest grade of washed sand and gravel. It is located within the best residence district of Norfolk at the mouth of the Tanner creek about 250 feet from the James river.

The plant is not unsightly and the grounds and office buildings are carefully planned, and as the power is supplied by electric motor, little noise is produced.

The material is brought to the plant on barges from the Potomac river and Virginia Beach. A locomotive crane that is equipped with a clamshell bucket unloads the material into a hopper, from which it is elevated by a continuous bucket elevator and raised to the screens. This elevator is thirty-two feet between centers and is equipped with 16x8x11¾-

inch elevator buckets. It is seen in the background of the photograph.

The screens wash and separate the material into the following sizes—sand, grits, roofing gravel and that passing a one-inch mesh. These are discharged from the screens into the bins below and graded according to the various sizes.

About 200 feet from the screen plant proper the concrete storage bins are located and connected to the same by means of an 18-inch belt conveyer 270 feet centers. This conveyer passes beneath the screening plant, which is arranged with chutes and gates, so that the material from any one of the bins may be drawn out onto the conveyer. Beyond the screening plant the conveyer rises on an incline until it reaches a point above the concrete bins, where it returns to the horizontal and passes over the bins. A hand-propelled tripper operates on a track above the bins, and it is so arranged that material from any bin below the screening plant may be delivered to the compartment in the storage bin used for the same size of material.

The storage bin is designed so that teams may drive beneath any part, and by means of quadrant-type gates, which may be operated from the driver's seat, the wagons are instantly loaded with the desired grade of gravel or sand. As the long storage conveyer returns to the horizontal about 100 feet from the bins, it has been possible to extend the tripper back out along this part of the conveyer and thus utilize the space below the trestle for emergency storage. The concrete bins are seen in the foreground of the photograph and the conveyer and emergency storage beyond.

It is of interest to note that the surplus sand is carried from the plant by an 18-inch belt conveyer, 70 feet centers, to a pile near the river, within reach of the locomotive crane. In this way the sand may be reloaded onto barges on the river and thus delivered by gasoline tugs and barges to various parts of the city, to Hampton Roads and the nearby smaller towns.

The separate concrete storage bin is the particular feature of interest in this plant, and under this arrangement the bins beneath the screening plant may be relatively small; and, as they do not need to be elevated above the team tracks, the screening plant proper is very low. This is of particular advantage, as it thus becomes unnecessary to support the machinery at an excessive height. This arrangement of storage bins also allows greater flexibility and allows an excess accumulation of any special grade when it is of advantage to hold it; or it is possible to by-pass some of the material delivered to the plant, which does not require screening, delivering it direct from the receiving hopper to the storage conveyer and thence into any compartment reserved for the purpose.

The emergency storage space below the conveyer trestle is an advantage not possible where the screens are placed above the bins and where it is only possible to store a limited amount of each size.

While this arrangement is not suitable under all conditions, it has been found most advantageous here, and it is probable that it may be adapted to other plants where the material to be screened is delivered from a distance and where supply and demand are more relatively constant.

GRAVEL WASHING PLANT *and its concrete storage bins, Norfolk, Va.*

Action of Alkali on Cement

An important addition to scientific literature is made by Technologic Paper No. 12 of the Bureau of Standards of the U. S. Department of Commerce, of which S. W. Stratton is director. The action of salts in alkali water and sea water on cements is discussed by P. H. Bates, chemist; A. J. Phillips, assistant chemist, and Rudolph J. Wig, associate engineer physicist of the bureau.

The investigations have been under way for some three and one-half years, most of the time under the charge of the authors with chemical and physical investigations in the laboratory and field tests in sea water at Atlantic City. Many different solutions of alkalies were used, and various proportions of sand and cement were used in making the test briquets. Fresh samples and samples which had completely set were compared.

The conclusions are considered tentative, on account of the relatively short period over which the investigation has extended, but some of them are quite clearly indicated by the results. They are abstracted from the report as follows:

1. Portland cement mortar or concrete, if porous, can be disintegrated by the mechanical forces exerted by the crystalization of almost any salt in its pores, if a sufficient amount of it is permitted to accumulate and a rapid formation of crystals is brought about by drying; and as larger crystals are formed by slow crystalization, there would be obtained the same results on a larger scale, but in greater time if slow drying were had. Porous stone, brick and other structural materials are disintegrated in the same manner. Therefore, in alkali regions, where a concentration of salts is possible, a dense, non-porous surface is essential.

2. While in the laboratory a hydraulic cement is readily decomposed if intimately exposed to the chemical action of various sulphate and chloride solutions, field inspection indicates that in service these reactions are much retarded if not entirely suspended in most cases, due probably to the carbonization of the lime of the cement near the surface or the formation of an impervious skin or protective coating by saline deposits.

3. Properly made portland cement concrete, when totally immersed, is apparently not subject to decomposition by the chemical action of sea water.

4. While these tests indicated that portland cement concrete exposed between tides resisted chemical decomposition as satisfactorily as the totally immersed concrete, it is felt that actual service conditions were not reproduced, and therefore further investigation is desirable. In service the concrete extends from the sea bottom to a point above high tide, where the wall or pile would always be exposed to the atmosphere. With this condition the sea water could be drawn up the wall by capillarity, the moisture evaporating and leaving the salts, which would become concentrated, and thus possibly cause disintegration, especially if mixture is porous. An additional series of tests is now being made, in which short piles seven feet in length are being placed in sea water so that two feet of the center portion will be exposed to the atmosphere. After various periods of exposure the piles will be sawed and the various sections tested for elastic properties and compressive strength.

5. It is not yet possible to state whether the resistance of cements to chemical disintegration by sea water is due to the superficial formation of an impervious skin or coating, which is subsequently assisted by the deposition of shells and moss forming a protective coating, or by the chemical reaction of the sea salts with the cement forming a more stable compound without disintegration of the concrete, or by a combination of both of these phenomena.

6. Marine construction, insofar as the concrete placed below the surface of the water is concerned, would appear to be a problem of method rather than materials, as the concrete sets and permanently hardens as satisfactorily in sea water as in fresh water or in the atmosphere, if it can be placed in the forms without undue exposure to the sea water while being deposited.

7. Natural, slag and other special cements tested in concrete mixtures showed normal increase in strength with age both in sea water and in fresh water.

8. In the form of neat briquets most of the portland cements of high iron content, several of the cements of high or normal alumina content and one special slag cement did not show any marked difference in tensile strength whether exposed to fresh or sea water for all periods up to two years. Other cements of various compositions showed signs of disintegration after a few weeks.

9. All cements resisted disintegration in sea water better in mortar mixtures than in the form of neat briquets. In most cases the mortar briquets had normal strength up to two years' exposure.

10. The physical qualities of the cement, which depend essentially upon the method of manufacture, would seem to determine its resistance to decomposition when brought into intimate contact with the sulphate and chloride solutions.

11. Contrary to the opinion of many, there is no apparent relation between the chemical composition of a cement and the rapidity with which it reacts with sea water when brought into intimate contact.

12. Tricalcium-sulpho-aluminate could

not be formed, and therefore disintegration could not result from this cause.

13. In the presence of sea water or similar sulphate-chloride solutions:

(a) The most soluble element of the cement is the lime. If the lime of the cement is carbonated, it is practically insoluble.

(b) The quantity of alumina, iron or silica present in the cement does not affect is solubility.

(c) The magnesia present in the cement is practically inert.

(d) The quantity of SO3 present in the cement up to 1.75 per cent. does not affect its solubility, but a variation in the quantity present may affect its stability by affecting its rate of hardening.

14. The change which takes place in sea water when brought into intimate contact with the cement is as follows:

(a) The magnesit is precipitated from the sea water in direct proportion to the solubility of the lime of the cement.

(b) The sulphates are the most active constituents of the sea water and are taken up by the cement. Their action is accelerated in the presence of chlorides. No definite sulphate compound was established.

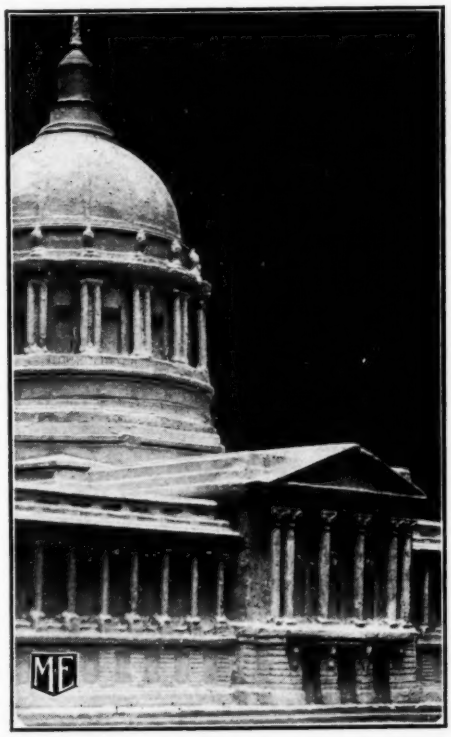
(c) The quantity of chlorine and sodium taken up by the cement is so small that no statement can be made as to the existence of any definite chloride or sodium compound formed with the cement.

15. The SO3 added to a cement in the plaster to regulate the time of set is chemically fixed so that it will not go into solution when the cement is brought into intimate contact with distilled water.

16. Metal reinforcement is not subject to corrosion if embedded to a depth of two inches or more from the surface of well-made concrete.

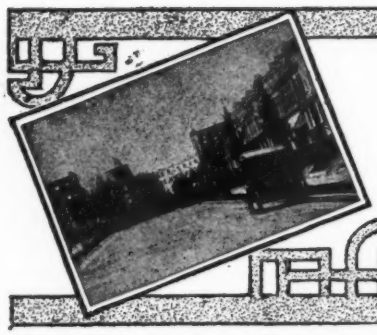
Patent on Concrete Dam

The Ambursen Hydraulic Construction Co., of Boston, has appealed from the recent decision, May 17, 1913, of the United States District Court for the Southern District of New York, which denies novelty in the claims of the Ambursen patent, ressiue No. 12,246, of 1904, saying that "the complainant's concrete dam is substantially a reproduction in concrete of an old and familiar style of timber dam. The flooring is supported by buttresses with spaces between. The complainant's concrete dam is claimed to have, and I am satisfied from the evidence it has, various points of superiority over the solid masonry dam. The cost is low. The material is plastic. It forms a solid mass without joints. But that is a feature of all concrete construction. The claim is that under this patent the complainant has a monopoly of dams made of concrete after an old style of wooden dams. The general rule is, of course, that the substitution of one material for another is not invention. Undoubtedly the complainant's form of concrete dam has many advantages; but they seem to me to result simply from the natural qualities of concrete, and not from any newly discovered qualities. If this patent is valid, the first maker of a concrete house or bridge or sidewalk was entitled to a patent for the thing made."



Design for New City Hall for San Francisco

The photograph of a part of a rough model of the successful design for the new San Francisco city hall shows the central tower and main entrance. Further study of the design and working out the requirements of the various departments has materially changed the original design and the architects, Bakewell & Brown of San Francisco, are now busy upon the detailed plans.



ROADS AND PAVEMENTS

The Brick Road the Cheapest and Most Economical

S. C. Andrews, an attorney of Conneaut, O., spent two or three months in an investigation of the road conditions in his county, Ashtabula, the results of which were presented at a good roads meeting held last month in Conneaut, which was illuminating in a number of ways.

He first showed the lack of system in accounting which provides no record of work performed or place or purpose of using materials purchased; which does not separate expenditures in road and bridge building and maintenance funds so that any reasonable approach to accuracy can be made in compiling figures of cost.

In the discussion of this part of the report the fact was brought out that there are several laws, not altogether consistent with each other, under which roads can be built and maintained. The principal laws are as follows: The Braun law is for use of counties building their own roads, the county paying 40 to 60 per cent. of the cost and the remainder being divided between the township and the property within a mile of the road. The Gehrett law, which has just been re-enacted and put in full force again, provides for the division of the cost of road building between the township and the property within a mile of the road, 40 to 60 per cent. on the township and the remainder on the property. Applications for such roads are made to the county commissioners and they order the construction. The State law provides that the State will pay 50 per cent., the county 25 per cent., the township 15 per cent., and the abutting property 10 per cent. of the cost of the improvement. The new Half-Mill law makes a levy of that amount to raise the State's portion of the cost of road construction and will raise about $3,250,000 a year. One-fourth of this amount is to be spent on the main market roads and the remainder is to be used in equal shares in aid of road build-

MACADAM *on Center Road near Conneaut, O. Note heavy dust and cloud raised by automobile.*

ing in the counties of the state, about $30,000 a year for each county acting under the State law, or by the State in the county in case the county does not act, in which case the county would get only half the length of road.

A difference of opinion as to the possibilities of action under these laws arose, a county commissioner contending that a single township which was taxed up to its limit for roads built under the Braun or Gehrett laws, especially the latter, would prevent the raising of the $30,000 required to be raised by the county under the Half-Mill law in order to get the full benefit of it. The State Highway Commissioner, however, showed how the money could be raised by bonds and these bonds and their interest could be paid under the provisions of the Smith law without violating any other state law.

It is evident that the complexities of the laws are too much for many county commissioners and that many of the errors complained of are due to lack of financial and legal ability of the county managers.

The laws do not give much attention to road maintenance, outside of the state aid roads, and Mr. Andrews reports pay so low and the qualifications of road inspectors and foreman so low, in the absence of any general method of fixing them, that there is little hope of improvement under the present laws. The pay of county commissioners is only $135.70 a month and no allowance for expenses. That of township trustees, who have charge of maintenance of roads not built under the laws, is not more than $150 a year, so that the lack of competent road men extends all the way from the general supervisors and administrative officers to the workmen in the field.

Perhaps the most important subject covered in Mr. Andrew's report is the relative cost of roads of different materials. His report is lacking in some details on account of the lack of full records and the distribution of items of expense among different funds, so that they are hard to collect according to any desired system. The road costs are probably fairly comparable among themselves, tho they may not be comparable with those in other counties or states. A few roads did not pay engineering expense. Others paid varying amounts from 3 to 12 per cent. Widths of improved surface vary from 9 to 28 feet. The cost of each road was computed per foot of width and per mile of length as perhaps the nearest to a comparable basis.

Macadam roads 9 to 16 feet wide cost from $506.54 to $762.33 per mile for each foot in width. Nine-foot roads cost from $4,560.89 to $5,273.25 per mile. Fourteen-foot macadam roads cost from $7,950.65 to $10,672.59 per mile.

Tar macadam roads 16 feet wide cost $13,874.90 per mile or $867.18 per mile per foot of width.

Tarvia X macadam road 26 feet wide cost $26,229.53 per mile or $1,008.23 per mile per foot of width.

Concrete roads 16 feet wide cost about $9,600 per mile or $598.57 to $609.11 per mile per foot of width.

A brick road 28 feet wide costs $26,613.44 per mile or $950.48 per mile per foot of width.

No figures of cost of maintenance are available. Three of the macadam roads, finished in 1908, 1909 and 1910, each 14 feet wide are now being resurfaced at an average cost of about $215 per mile per foot of width. If we estimate the average life of these pavements at 3½ years, the maintenance cost is practically $6 per mile per foot of width per year, or $84 per mile per year for the 14-foot roads in addition to any expenditures that may have been made in maintaining these roads during their life-time. As nearly as can be computed from the figures in the Andrews report, the average cost of

MACADAM ROAD *near Conneaut, O. Note depth of rut.*

BRICK ROAD *with cement filler near Conneaut, O. Note perfect surface.*

maintaining the 40 miles of improved road included in it is about $130 a mile a year; or practically double the cost per mile per foot of width per year of the resurfacing done on the three roads, the average width of macadam roads being about 11 feet.

The brick road has had no repairs except those made by the street railway, replacing bricks laid with asphalt filler between the rails, when the vibration of the tracks under car traffic raised the bricks from their bed.

On one of the macadam roads resurfaced there is a stretch of 6 per cent. grade which has been resurfaced with tar treatment twice in nine months.

The accompanying photographs show three of the roads included in the Andrews report. The first photograph, taken May 5, 1913, is of Conneaut macadam road No. 1, one mile south of the city limits. This improvement, 1.34 miles long and 14 feet wide was constructed of macadam in 1907-1908 at a cost of $631.93 per mile per foot of width. This pavement is in process of resurfacing using a tar treatment in 1912-13 at a cost of about $215 per mile per foot of width, as above stated. This makes the total cost of the road, including 1913, $846.93 per mile per foot of width, plus whatever may have been expended upon the maintenance of the road between 1908 and 1912. This road is very dusty at present and needs the resurfacing altho it has a reasonably smooth surface.

The second photograph, taken May 5, 1913, shows Conneaut macadam road No. 2, 2½ miles south of the city limits. This improvement, 2.07 miles long and 14 feet wide was constructed of macadam in 1908-1909 at a cost of $762.33 per mile per foot of width, and is the highest cost macadam road in the county. This road is in much worse condition than the one shown in the first photograph and will be resurfaced at once under the estimate of $215 per mile per foot of width, as above stated. This makes the total cost of the road, including 1913, $977.33 per mile per foot of width.

The third photograph, taken May 5, 1913, shows the Conneaut brick road, which is the Ridge road from Woodworth Road east to the Pennsylvania State line. It was built in 1908-1909 of shale brick on natural soil foundation with grout filler, 1 cement to 1 sand, except the area between and just outside the street car rails, which has an asphalt filler. The pavement is 1.52 miles long and 28 feet wide and cost $950.48 per mile per foot of width. It has cost the county nothing for repairs to date, and from the appearance of the photograph this statement will be true for many years.

Comparison of the cost to date of these pavements shows clearly the greater economy of brick. Altho its first cost is 25 to 50 per cent. higher than the macadam roads of about the same age, its lack of maintenance cost brings it down to the same or less cost at the end of three or four years' use, and from this time on the brick pavement will be the cheapest. This does not include the greater interest charge on the investment in the brick pavement, which would equalize this difference.

The brick pavement has never been swept and its freedom from dust, as compared with the macadam pavement, is evident. Convenience, continuity of service, ability to carry greater loads and more rapid travel, all count to the advantage of the brick pavement. It is also more than probable that a macadam pavement in the same place would have demanded greater expenditure for maintenance than those given, because of the presence of the street car tracks and the consequent tendency of traffic to form ruts.

Municipal Asphalt Repair Plant at St. Paul, Minn.

In the budget for 1912 $15,000 was appropriated in the general fund for the purchase of equipment for making street paving repairs. In February bids were called for for a portable asphalt plant, and later other equipment was purchased under competitive bids. The entire plant installed under this appropriation and in use in 1912 consists of a Warren Bros. portable asphalt plant, one 8-ton asphalt steam roller, one scarifier, one Lutz surface heater, one fire wagon, one gyratory stone crusher, two portable melting kettles, six 2-yard steel-lined asphalt wagons, four ¾-yard concrete spreaders, one set of curb cutters' tools, nine asphalt rakes, testing scales and the necessary small tools. While the plant is a portable one, it has been located centrally to the work to be done and on trackage, thus simplifying handling of materials, and has been kept constantly in the one place.

The plant was put in operation April 25, and during the season was worked a total of ninety-two days; 19,428 square yards of asphalt pavement were turned out, 15,040 square yards of this being cut-out work and 4,388 square yards burner work. There were 5,458.63 square yards of asphalt put in for paving contractors in repairing asphalt pavements under guarantee. Of this 2,363 square yards were cut-out work and 3,095 square yards burner work. The total cost was $6,012.96, which was billed against the contractors and collected.

There were 2,902 square yards of asphalt put in for the Street Railway Co. and billed against it, the cost being $4,363.50; 1,636.44 square yards of asphalt were put in for public service corporations, costing $2,944.48 and being billed and collected; 1,029.53 square yards of asphalt were put in on bridges on which the city maintains the wearing surface. This cost $1,961.57 and was charged against the bridge building and repair fund at $1.65 per square yard, excepting the Rice Street bridge, which was charged at $2 per square yard on account of special work and additional depth of asphalt. One hundred and twenty-seven square yards of asphalt were put in for miscellaneous parties and charged to them, this cost totaling $281.21.

The repairs to asphalt pavements out of guarantee and paid for out of the street and sewer fund, amounted to 6,981 square yards of cut-out work and 1,293 square yards of burner work. This repair work cost the city $7,163.50, or an average of 86 cents per square yard.

The operating crew at the plant consisted of one foreman, one engineer, one tank man, four laborers and a night watchman. Four teams were employed in hauling asphalt from the plant to the work.

The street crew was made up of one foreman, one timekeeper, one roller man, two rakers, two tampers, one smoother and one cement man putting in new pavements, two shovelers, six scrapers and two teams removing and hauling the old paving. The total expense was divided as follows:

Labor

Operation of plant	$ 2,535.00
Unloading material	255.62
Removing old paving and puting in new	7,116.48
Hauling asphalt	780.40
Shelter shed and misc	178.98
Total expenditure for labor	$10,866.48

Material

Asphalt, Trinidad Lake	$ 6,507.46
Fluxing oil	1,927.61
Fine sand	960.00
Coarse sand	182.00
Fuel oil	858.96
Coal for plant	420.35
Stone dust	465.00
Crushed stone	306.24
Cement	297.00
Road roller fuel	162.50
Wood	34.00
Advertisement	11.60
Resetting radius curb	32.83
Freight	1.15
Surface heater	382.48
Auto hire	40.00
Waste	7.13
Kerosene	22.74
Tool repair	54.52
Equipment	26.32
Small tools	99.18
Oil and supplies	88.28
Miscellaneous material	60.05
Total expenditure for material	$12,947.40

Total expenditure for labor and material, $23,813.88.

Material on Hand at Asphalt Plant, January 1, 1913

6,825 gal. fluxing oil	$ 518.51
50 cu. yds. fine sand	50.00
15 cu. yds. coarse sand	7.50
24,000 lbs. raw asphalt	372.00
350 gal. fuel oil	26.21
600 empty dust sacks	60.00
250 empty cement sacks	25.00
½ cord maple wood	4.00
1/3 bbl. cylinder oil	9.50
1/3 bbl. engine oil	3.50
25 lbs. cup grease	2.50
2 bxs. Garlick packing	2.50
6 pcs. asbestos pipe covering	4.04
1 lb. acorn packing	.75

35 fire brick	10.50
1 bundle tar paper	.60
Total material on hand	$1,097.11

Total labor and material used, $22,716.77.

SUMMARY

Total labor	$10,866.48
Total material	12,947.40
Total cost of labor and material	$23,813.88
Charged to outside parties	$13,591.70
Charged to bridges	1,961.57
Material on hand	1,097.11
Total credits	$16,650.38

Total cost of city work, $7,163.50.

In figuring the above costs no depreciation of plant or interest is charged, but all small tools have been charged against the work.

Prospective Opportunities for Highway Engineers in a National .. Highways Department

By Charles Henry Davis, C. E., President National Highways Association, before the Society for the Promotion of Engineering Education.

To begin at the end—the opportunities are unlimited! But why? We grew as a nation during the scientific growth of the world, so to speak. Prior to this period other and older nations had provided themselves with highways. Methods of intercommunication, up to the limits of apparent needs, are essential to the well-being of any people. People, like water, stagnate if confined to one locality. They must run and play, like the brook itself, or become sluggish and dull —to themselves as well as to others. Hence before the coming of steamboats, railroads, the printing press, and electricity roads were built by the older nations so that their peoples could move. Roads were the only means they had of intercommunication. But we came to be a nation when these modern methods of connection and communication were being perfected. As these means were more rapid and as our country was so large, their development pushed one side the building of roads. We were too busy for road-building and our need therefore was not then so apparent. But now we are, as a nation, awakening to the lack of our forethought, the pressing necessity and the vital importance of road-building. This is evidenced by some fifty major good roads or allied associations, five hundred state and local organizations, the same number or more automobile clubs, and some one hundred thousand road officials thruout the United States. We are probably now spending directly and indirectly over $500,000,000 per annum on the roads of the country. And yet we have less than ten per cent. of our 2,300,000 miles improved—or with the semblance of improvement, such as it is. What will we spend to make them all good roads, and to maintain them? No one can tell. No one can foresee. But it is safe and conservative to predict over $1,000,000,000 per annum during the next twenty-five years, or an investment exceeding that on our steam railroads. And then we shall only have made a beginning.

To carry conviction of the coming of this vast expenditure and the economic necessity therefor: It has been estimated that more than five billion tons of freight per annum pass over our highways. Of this more than half would probably go over a system of national highways. It is estimated that the present average haul is a little under ten (10) miles and that the cost is about twenty-three (23) cents per ton per mile. This cost should not exceed eight (8) cents per mile on a good road. In other words, at least one dollar and a half ($1.50) should be saved on every ton moved on our highways. Thus the total saving from good roads staggers the imagination. Our railroads carry two billion tons of freight per annum. If, instead of the above estimate, we assume that only an equivalent tonnage passes over our highways, then the saving per annum would be $3,000,000,000 on a system of good roads. The probabilities are that the saving would be far greater.

The value of farm real estate and buildings is $35,000,000,000 for the United States. Two million miles of improved highways will increase land values some $10,000,000,000, or approximately an increase of one-third above present values. Does this indicate we cannot afford to improve all our roads? There are 6,500,000 farms. This means that the average increase of value for each farm would be $1,500. At $100 a year per farm we would have a sum of $650,000,000 per annum with which to improve our highways. This would build 130,000 miles a year at $5,000 per mile, or less than twenty years within which to improve all our highways. In this time they would many times pay for themselves in savings and also in increased land values.

Such figures could be multiplied. It is therefore beyond any reasonable doubt that the nation will spend the moneys needed to produce such magnificent returns in both usefulness and economy.

But there is another side of even greater importance—civic, moral, and educa-

tional—which far transcends the material and commercial part of the problem. We cannot have good schools in the rural districts without good roads. And we must have good schools.

The relation of good and bad roads to illiteracy is indicated by the following facts:

Illiteracy is eleven (11) times greater in the South Atlantic States than in New England, while the percentage of improved roads (such as they are) is about one-fourth. Similar figures for the Pacific and West South Central are: fourteen (14) times greater illiteracy, while the percentage of improved roads roads is less than half (½) as much. The illiteracy in rural New England is one hundred and forty (140) per cent. of that of urban population, while in the South Atlantic States this increase is nearly three hundred and fifty (350) per cent., due to the lower percentage of improved roads.

The children of today are the electors, the representatives, the senators, the judges, one of them the President, of tomorrow. The population is increasing by leaps and bounds. If education means liberty, and if poor roads mean illiteracy or worse, have we a right not to build good roads, even if they would not pay for themselves well within the generation which builds them?

And of equal importance—our people cannot get "back to the land" unless we have good roads. They must get back for us to live as a nation!

The evidence is therefore overwhelming that greater sums are to be spent on the roads of the United States within the next generation, than on any other activity of the body politic. They will be used by all. They will be paid for by every one of us. They will be free to all of us. They will be of untold, daily advantage to us.

All this being true, is it not apparent that the opportunities are unlimited? In being unlimited there is a serious side to it. Will all the educational institutions, including the National Government, be able to educate highway engineers rapidly enough to supply the need therefor? We think not. Decidedly not! Therefore the greater the facilities offered for such education the better for good roads, whether these facilities be private or public, state or national. We cannot obtain, in time for our needs, the education and therefore the knowledge we need properly and economically to build the good roads of the coming generation. The opportunities for the highway engineers are therefore unlimited in or out of a National Highways Department.

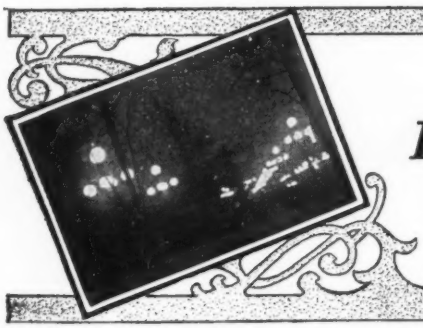
Wide Tire Legislation Demanded

A meeting of leading state highway commissioners and the manufacturers of horse-drawn wagons and motor-driven trucks is the suggestion of Chairman George C. Diehl of the A. A. A. National Good Roads Board, who contends that the time has arrived when those interests can advantageously discuss the drafting of suitable legislation governing the width of tires and the weight of loads. After an interchange of views a committee could prepare laws the passage of which would be practically assured when put forward by the chief highway officers of the various states.

"Many states have enacted laws which endeavor to regulate the width of tires of vehicles, but unfortunately there has not been strict enforcement of these regulations," says Chairman Diehl. "The width of tires is one of the important factors in highway construction and maintenance. Narrow tires, especially during the wet season, form ruts in improved roads and in many instances, where the roads are weak, break thru the surface, with the subsequent rapid destruction of the highway.

"One great difficulty in enforcing wide tire ordinances with horse-drawn vehicles has been that while less traction is required with wide tires, on slippery clay or hilly roads it is very difficult in wet weather to manage a horse-drawn vehicle with wide tires, owing to its tendency to skid and slide into the ditches. Instances are frequent where in a journey a farmer must drive over miles of slippery road and only have a few miles of improved highway, in which case he would naturally prefer to use narrow tires for the entire distance, rather than to attempt the use of wide tires over the slippery section of the road.

"There is no question that protection and economical maintenance of improved highways require that narrow tires should be discarded, and ordinances must be enforced which will prevent their use on main traveled highways which have been improved at great expense. If a vehicle owner desires to use narrow-tire wagons or slippery roads, he must be absolutely prevented from using the same tires on improved roads. Equal, if not greater, damage can be done to the highway with tires of insufficient width on motor trucks. There is no state where wide tire ordinances are drawn which relate to both horse-drawn and motor-driven vehicles, or where a scientific attempt has been made to prepare such ordinances or where a strict enforcement is had.



FIRE AND WATER

Sanitary Significance of the More Common Constituents of Water

By George A. Johnson, before the American Water Works Association.

Eliminating from discussion for the time being all forms of bacterial and other microscopic life, let us first consider the evidence bearing on the sanitary significance of the more common constituents of water, as determined by chemical analysis.

Physical Features

Under this heading, of course, come taste and odor, color and turbidity. What effect on the health of the consumer have these features as applied to water?

A water heavily charged with mud will naturally possess an argillaceous or clayey taste and odor, the same being intensified on heating. This is not agreeable to many. Assume that a water contains on the average 100 parts per million of suspended matter. In a year's time an adult will consume in this way about 1/7 pound of such matter, or some 5 pounds in a lifetime. This quantity will go a considerable distance toward the "peck of dirt" a person is supposed to eat in the course of a lifetime, but in itself cannot be considered as having any sanitary significance.

Water which is naturally highly colored sometimes possesses a slight astringent taste, but such coloring matters, being vegetable stains for the most part, can have no deleterious effect on the health of the consumer.

Some waters possess offensive tastes and odors due to growths in them of certain higher forms of microscopical life, and due to the liberation by them of essential oils in the process of their development or decay. These are relatively small in quantity, and cannot in themselves actually cause serious disturbances in the body of the consumer.

Some waters are so heavily polluted with certain industrial wastes as to give them a highly objectionable taste and odor. Probably the most prominent in this line are waters tainted with the waste liquors resulting from the destructive distillation of wood and coal. Creosotes, phenols and similar compounds are especially offensive and far reaching. A very few drops of creosote will impart a marked taste to a gallon of water.

At Marquette, Michigan, trouble of this kind was encountered, and only overcome by moving the water works intake far out into Lake Superior, and locating it some 50 feet or so below the surface. It will be recalled that the waters of Lake Superior are not subject to periodic overturn, as are those of the remaining Great Lakes.

In some streams in Pennsylvania this sort of water pollution has become a serious nuisance. Warren, Pennsylvania, has experienced a great deal of trouble of this kind, and likewise New Castle, Pennsylvania.

At the latter place the creosote liquors came from the by-product coke plant of the Carnegie Steel Company, located at Farrell, on the Shenango River, and some 20 miles above the intake of the New Castle water works. The waste liquors from this plant amounted to some 160,000 gallons daily, and the amount of creosotes and phenols to a maximum of about 200 pounds daily. Now it so happens that the minimum daily flow of the Shenango River at Farrell is about 15,000,000 gallons, therefore the creosotes equalled under these circumstances .000228 grain per gallon, or .0039 part per million. The theoretical dilution was 1:9000. A strong creosote taste and odor was imparted to the water, and this, as was anticipated, could not be removed by moderate aeration, treatment with lime and sulphate of alumina, and subsequent rapid sand filtration. The difficulty was only overcome when the Steel Company impounded all of the wastes of the coke plant, and afterwards used them for coke quenching, in which process, of course, they were vaporized.

Now as to the sanitary significance of such substances in water. Let us assume that the 200 pounds of creosotes and phenols were all pure creosote. The

medicinal dose of creosote may safely be taken at 10 drops. To get a single medicinal dose from water polluted as above it would be necessary for one to consume over 30 gallons of the water. Furthermore, creosote is not a cumulative poison, but is rapidly excreted thru the pores of the body, leaving nothing behind.

Finally then, those physical characteristics natural to many surface waters which lend to them an unsightly appearance, or an objectionable taste and smell, are of actual injury only in so far as they may affect the individual imaginatively. This feature is not to be disregarded, however, for there is no doubt that many thousands of people actually have thought themselves into the grave. One of the first lines of common-sense water logic, therefore, is that drinking water shall be free from perceptible quantities of color and turbidity, and that it shall possess no disagreeable, or actually foreign, tastes or odors.

Organic Matter

Under this heading, altho it may not be precisely correct, we will include all nitrogenous matter, such as free and albuminoid ammonia, nitrites and nitrates; and carbonaceous matter, such as "oxygen consumed" and the like; in short, all organic matter found in water, both of vegetable and animal origin, whether derived from human or animal excrement or from the wash of woods and fields. It is necessary at this point only to eliminate living bacteria from discussion. They will be considered later on.

There is nothing in the complex compounds of organic matter commonly found in water supplies which need give alarm to the water consumer. Prior bacterial decomposition of such matters, doubtless, is instrumental in producing certain ptomaines, which in sufficient quantity would exert in some degree a toxic effect on the human organism. But while such conditions might be conceived of in sewage, in water, even after it has received sewage up to the limit of its powers of digestion, the dilution of such substances is too great to warrant serious consideration being given to this feature.

While it is aesthetically repugnant to conceive of drinking water supply originating from crude sewage, yet sewage, if thoroly treated with chemicals and filtered, may be made perfectly safe for human consumption. Consider in this connection the purification of Bubbly Creek water at Chicago. This creek, receiving the sewage of some 400,000 people, is in a practically continuous state of fermentation. In its raw state it is slate-color and putrescible, and contains at least five times as much nitrogenous, and twice as much carbonaceous organic matters as the ordinary run of polluted raw river waters. The bacteria always range around 1,000,000 per cubic centimeter, and forms of sewage bacteria are always present in relatively large numbers. By coagulation, sedimentation, sterilization with hypochlorite of lime followed by rapid sand filtration, a clear and sparkling effluent was obtained during a test of the purification process referred by the writer in 1908. The filtered water contained 8 parts per million of oxygen consumed, 2 parts of free ammonia, 0.14 part of albuminoid ammonia, 23 parts of chlorine, but under 50 bacteria per cubic centimeter, and B. coli rarely ever present.

A short time after this purified water was turned into thte stockyards the matter became the subject of litigation, the city contending that it was illegal to use water derived initially from such a foul source as Bubbly Creek, even though it was later purified. The testimony for the defense brought out some interesting points bearing on the potability of such purified waters, which, while free from dangerous bacteria, still contained high amounts of animal and vegetable organic matter of known sewage origin. It was shown that the waters of the Seine at Suresnes and Ivry, and of the Norder Elbe below Hamburg, where Altona obtains its supply, are in more or less the same class of foully polluted waters, but are purified and made safe for human consumption, even tho they still contain in large quantities organic matter of sewage origin.

The prosecution endeavored to establish the fact that, even tho the water was made pleasing to the eye and rendered practically free from bacterial life, the filtered product still contained dissolved organic matter in such quantities as would be likely to exert a toxic influence on persons drinking such water continuously. Evidence to combat this view was furnished, referring particularly to the report of the National Board of Health, Senate Doc. Second Session, 47th Congress, 1882-1883, Volume 1, part 2, page 201; Second Report of the Royal Commission on Sewage Disposal of Great Britain, 1902, page 27; Report of the Massachusetts State Board of Health, 1890, page 537, an dother published documents.

Professor E. G. Smith of Beloit College testified that in his opinion the water as delivered from the Bubbly Creek filter plant was a more safe and usable water supply than the city supply derived from Lake Michigan; and Prof. John H. Long, a noted toxicologist, and a member of the so-called referee board, a commission appointed by President Roosevelt to study and report on the effect of the food preservatives, testified

that the filtered water did not contain substances which are to be considered harmful, and that, while he was unable to state an exact maximum permissible limit, the amount of dead organic matter still remaining in the filtered water was well within the safe limit. Furthermore, he stated that there is absolutely no difference between organic matter coming from sewage and that coming from decayed vegetables, that the protein matters are the same, and that they yield the same decomposition products.

Still further evidence is furnished by the testimony of Count Le Couppey de la Forest, Secretary of the Commission d'Etude des Eaux of Paris, France, given in the case of the State of Missouri vs. the State of Illinois and the Sanitary District of Chicago, 1903, pages 4829, et seq. There he stated that the effluent of the sewage farms of Paris is drunk exclusively by all of the 200 to 400 workmen, and close watch on their health is kept by regular city physicians who report weekly upon the health of these men; and during the past twenty or more years, in fact since these sewage irrigation farms were first started, there has occurred among these workmen no case of typhoid fever, or cholera or dysentery or any other of the diseases which are water borne.

Without evidence to sustain the point how can it be concluded otherwise than that dead organic matter, in such quantities as are found in water, has not the slightest actual sanitary significance? Again we are forced to fall back upon the aesthetic phases. One who first looks at a foully polluted and stinking body of water naturally rebels at drinking it even after purification, and when he knows it cannot harm him. If he had no knowledge of its source he would accept it without protest. But how do the results of chemical analysis actually benefit him or anybody else when recording the free and albuminoid ammonia, the oxygen consumed, the nitrites and the nitrates as being present in this and that amount?

Chlorine

The effect of chlorine on the public health, in the quantities and as found in water, is nil. The average individual consumes at the table each day many times as much salt as is ever present in a drinking water supply.

Hardness

It is the contention by some physiologists that those constituents which make water hard are deleterious to the public health. In some cases this view would seem to have considerable merit. The traveler is unpleasantly reminded of the effect of abruptly changing from a soft to a hard water, and vice versa, but there are no statistical data to prove that in general the hardness of a water has any clearly defined effect one way or the other on the public health. Altho it is strongly maintained by some that various specific diseases such as urinary calculi, goitre, etc., are produced by the continued use of vary hard waters, the confirmatory data to prove out this view are lacking. It is much more probable that the effect of hard waters is really restricted to simple gastric and intestinal disturbances, which are temporary only in their effect.

Iron

The chief objections to iron in a water supply, from a sanitary standpoint, are its undesirable taste and appearance, when present in sufficiently large quantities. Where it comes from the source of supply it can readily be removed by aeration and filtration; and when it comes from the service pipes thru the corrosive action of carbonic acid and other agents, corrective measures have to be taken before the water is delivered into the mains.

The sanitary significance of iron in water may be considered as nil, for when present in large amounts its undesirable taste would preclude its use.

Organisms Found by Microscopical Examinations

Water supplies are examined for the higher forms of microscopical life as a routine procedure in but few places. In the majority of cases such examinations are carried on only at times when the water possesses objectionable tastes and odors, the endeavor at such times being to locate and identify the organism which is causing the trouble. Knowing the kind of organism, it is relatively easy to destroy it at its source thru chemical treatment.

Where water works systems include large impounding reservoirs or storage basins such examinations may, to advantage, be carried as routine, except, perhaps, during the cold winter months. With a continuous record of the kinds and numbers of microscopical forms common to a water it is possible to anticipate by prompt chemical treatment a heavy growth which otherwise would result in the production of offensive odors and tastes.

Aside from aesthetic objections due to the appearance of "slime" in the water, and of offensive tastes and odors, due to the growth of such microscopical life, and all preventable by promptly instituting proper chemical treatment, such higher forms of microscopical life have no sanitary significance.

Bacteria

It is the almost universal custom in water works laboratories to make daily analyses of the water supply for total numbers of bacteria; in some the number of bacteria developing on special media at body temperature is also determined; and in many presumptive tests for B. coli are carried as daily routine. There is no question that the results of bacterial analysis are of more value in determining the hygienic quality of a water than the entire chemical and microscopical data laboriously and expensively obtained.

Bacteriology is a comparatively new science, and by no means a precise one. It is a matter of common knowledge that with the methods of analysis of today the bacteriologist can isolate and positively identify specific disease germs only with the greatest effort and difficulty, and even then it is of primary importance that their number and virulence be also known before the water can justly be condemned. The finding in water of germs known to be associated in one way or another with disease-producing germs furnishes valuable circumstantial, but nevertheless indefinite, evidence.

Sometimes the presence of comparatively large numbers of bacteria in water has no sanitary significance whatsoever. This is true even when the evidence is quite positive that among the number are forms whose best known habitat is the intestines of man and domestic animals. Waters draining uninhabitated areas, and therefore far removed from opportunities of pollution, particularly where the areas drained are swampy, sometimes show high numbers of bacteria.

The test for B. coli is the usual way the present day bacteriologist has of ascertaining the relative purity of waters, also of forming a judgment of the purity of an individual water. This organism is the normal inhabitant of the intestines of man and some domestic animals, and of course is always present coincidentally with the typhoid germ when a person is suffering from that disease. It is equally true that in the vast majority of cases where B. coli is found in water the typhoid bacillus is absent. Therefore, where B. coli is found the inference that B. typhosus is or may be present furnishes circumstantial evidence purely, yet because the typhoid bacillus may be isolated from water only with the greatest difficulty, and because the reverse is true of the colon bacillus, the presence of absence in water of the latter organism is looked upon as the surest index of sewage pollution available to modern water bacteriology.

But the colon bacillus found, even if the number of coli be large, may have come solely from the excreta of domestic animals, or even from fish, and such animals do not suffer from typhoid fever. Again, the bulk of the coli may come from the excreta of perfectly well persons, and where a water is contaminated with city sewage this is always the case. So its presence in water merely furnishes evidence that it has been polluted with animal excrement; that typhoid fever germs may be present, but no proof that they are.

A water may contain a few stray coli and yet be perfectly safe to drink, for they all may have come from domestic animals. Furthermore, soli may have entered a water months before, even accompanied by typhoid germs; but both of these organisms, being out of their natural habitat in water, quickly become attenuated and lose their virulence.

In judging a water by the presence in it of B. coli, it is necessary to possess a knowledge of the number of these germs and of their vitality, in order that it may be known whether the pollution is recent, in what relative amount, or if it occurred a long time in the past and the germs found represent the attenuated survivors of those which entered the water originally.

The numbers of bacteria in a water and the results of the test for coli have a definite, tho limited, value. High numbers of bacteria and the persistent appearance of B. coli can only mean a dangerously polluted water. Not that it is actually unsafe to drink all of the time, but that at any time it may become so. Low numbers of bacteria and no coli can only mean a water of high sanitary purity.

The absolute value of bacteriological examinations is difficult to express except in this manner. B. coli may be present in a water every day for weeks and months on end and the water be perfectly safe. At Cincinnati, Ohio, during the year 1912, daily tests showed B. coli in the filtered supply three times out of every four when 100 cubic centimeter volumes were examined; and once in every twenty times where one cubic centimeter quantities were tested, yet the typhoid fever death rate in Cincinnati for that year was 7 per 100,000 people living, one of the lowest typhoid death rates recorded for that year among the cities of the world. An ordinary drinking glass will hold about 250 cubic centimeters of water, so according to the results of the Cincinnati analyses B. coli was probably present in every glass of drinking water, yet the typhoid fever death rate among its consumers was exceedingly low.

Ordinary city sewage contains about 500,000 B. coli per cubic centimeter, hence, on a basis of 100 gallons per capita daily sewage flow, one person will dis-

charge 190,000 million coli each day. On the basis of a stream flow of 3 cubic feet per second per 1,000 population contributing sewage, such water would contain immediately after the entrance of the sewage 26,000 colon bacilli per cubic centimeter, or about 6,500,000 in every glassful. Increase the above stream flow 50 times. Assume that 90 per cent. of the coli are removed by purification of the sewage before it enters the stream and the number of coli in a stream so polluted become 52 per cubic centimeter, and about 13,000 in every glassful. Then further assume that 90 per cent. of these coli are eliminated shortly after entering the stream, thru such agencies as osmosis, etc., and there remain 5 coli per cubic centimeter, or some 1,250 in a glassful of water.

Now take, for purposes of discussion, a city wherein the annual typhoid death rate is 10 per 100,000 population living. About 100 persons would suffer with this disease to cause this death rate. Assume that the cases are evenly distributed thruout the year and that the number of typhoid bacilli discharged by them is equal to the number of coli. Assume also, of course, that no attempt is made to disinfect the typhoid excreta, and that it all enters the stream in a crude state; then in water so contaminated and diluted, as described above in the first case, and before the numbers of bacteria are reduced by purification or other agencies, there would be 26,000 colon and 4 typhoid bacilli per cubic centimeter; and the ratio between the number of coli and the number of typhoid bacilli, under these assumed conditions, which are intended to be the worst one is warranted in imagining, would be about 7,000 to 1.

The purpose of the above discussion is to show, in an elementary way, that B. coli may be present in water in large numbers but not necessarily be accompanied by typhoid germs, or prove that the water is dangerous merely because it does contain coli. It is a sure index of fecal contamination and indicates danger. Would it not be better to conclude, therefore, that water showing coli in any number, at any time, and under any set of conditions is to be considered suspicious and to require treatment? Coli will always be found where the typhoid germs are, even tho the latter are infrequently present when the colon bacillus is found.

From a strict hygienic standpoint there are no "pretty good" waters. A water is either polluted or it is not. If polluted it must be purified. The danger may be, and is, greater in proportion to the degree of sewage pollution, but any degree of danger is not admissible in the public water supplies of the present age.

Public Well and Water Supplies From Gravel and Sand

Two exhaustive papers on underground water supplies for municipalities have been presented recently, which contain much of value on the subject of wells in gravel and sand. One of these is the paper on "Quantitative Estimation of Ground Waters for Public Supplies," by Myron E. Fuller, presented March 12, before the New England Water Works Association, and the other on "Basic Principles of Ground Water Collection," by Charles B. Burdick, presented June 26, before the American Water Works Association. The following concerning supplies from sand and gravel is collected from the two papers, first abstracting from Mr. Fuller:

The water-bearing capacities of sands and gravels are largely a factor of their porosities. Where the grains are all of the same size, the porosity is independent of their diameter. For instance, the large number of small pores in a sand are equivalent in volume to the comparatively small number of large pore spaces in a gravel. When, however, small grains fill the spaces between larger ones, as sand grains between the pebbles of a gravel, the porosities are much reduced. Altho the size of grains in uniform sands or gravels does not affect the porosities, their arrangement is of great importance. When arranged in the loosest possible manner, they have a porosity of 47.6 per cent.; where arranged in the most compact manner, the porosity is only 26 per cent. The actual porosities in nature are usually about midway between the two. In laboratory tests the porosities of uniform sands and gravels are found to be about 35 per cent., and of mixed pebbles and sand, which is the ordinary condition of our gravels, about 30 per cent. In nature the materials are subject to pressure, due to the weight of the overlying deposits, equal to about one pound for every foot in depth. This pressure produces a compacting, according to laboratory experiments with pressures of from 0 to 100 pounds per square inch, made under my direction by Mr. L. C. Creminant in connection with some recent investigations for the city of San Francisco, of from 5 to 8 per cent., reducing the actual probable porosity in the ground by an equivalent amount.

When water is withdrawn from a sand or gravel, a certain quantity remains behind as residual moisture, and is not yielded to wells. The quantity thus withheld varies with the size of the grain from 5 per cent. in the gravels to perhaps 20 per cent. in the finer sands or those approaching silts in texture. It

still further reduces the effective porosities or available storage. The reductions due to compression and residual moisture are shown in the following table. The last column shows the quantities of water actually available.

Effect of Porosity Deductions

(Per cent. of volume.)

	Porosities of Loose Materials. (Laboratory Tests.) Per Cent.	Loss of Porosity Due to Weight of Overlying Material. Per Cent.	Loss Due to Water Remaining in Pores. (Res. Moisture.) Per Cent.	Effective or Available Porosity. Per Cent.
Gravel (mixed sand and pebbles)	20-30	5-8	4-8	10-20
Sand (medium to coarse)	30-40	4-6	6-10	15-25
Sand (fine and very fine)	30-40	0-5	10-25	5.20

The quantity of water stored in the sands and gravels is not the only thing that must be considered. The real determining factor in a permanent supply is the rate of replenishment. In an inclosed basin or other area not receiving outside supplies, replenishment is mainly from rainfall. The whole rainfall is, of course, not available, large deductions being necessary for evaporation and surface runoff.

In sand and gravel deposits receiving contributions from outside their own areas, as is the case of most of the formations in stream valleys, a determination of the rate of underflow is necessary to fix the quantity of accessions from sources other than rainfall. When replenishment occurs from a stream flowing over the surface of the deposits being drawn upon, a still further determination, that of downward percolation, is necessary.

A fairly exact determination of the rate and volume of underflow can be made by actual measurement by the electrical method devised by Prof. Charles S. Slichter, of the University of Wisconsin and the United States Geological Survey. In brief, the method consists in sinking four 2-inch wells in the form of a fan or triangle, the apex of the system being toward the supposed direction from which the water is moving. Common salt or ammonium chloride is inserted in the apex well and the time required for penetration into the other wells taken by electrical recording apparatus or determined from water samples taken and tested at short intervals. The rate of percolation from streams is best determined by the Slichter method used in conjunction with a pumping test.

Where a direct test is not made, it is possible to form an approximate idea of the rate and volume of underflow by computations based on temperature, size of grain, porosity, head, etc. It may be stated that size of grain and temperature are factors of the greatest importance. The flow thru a sand whose effective size of grain is 1 mm. or about 1-25 inch, which may be regarded as a fairly coarse sand, is 10,000 times that thru a clay whose particles have an effective size of .01 mm. The flow at 70 degrees is about double that at 32 degrees. Again, the movement of water thru sands of the same size of grains varies with the nature of the packing, a sand with a 40 per cent. pore space having a movement of 2.6 times that thru one of similar grain but with packing giving a 30 per cent. porosity.

Something of the actual rates of underflow movements under ordinary conditions is indicated by the following table:

Common Rates of Underflow

(After C. S. Slichter.)

(Gradient or Head, 10 Feet Per Mile; Porosity, 32 Per Cent.; Temperature, 50 Degrees Fahr.)

Materials.	Diameter of Grain in Millimeters.	Movement in Miles per Year.	Movement in Feet per Year.	Movement in Feet per Day.
Fine sand	0.2	0.01	52.8	0.145
Medium sand	0.4	0.04	216.0	0.6
Coarse sand	0.8	0.16	845.0	2.3
Fine gravel	2.0	1.02	5,386.0	14.76

Yield of Isolated Areas of Sands and Gravels

The yield of wells in isolated areas is dependent upon the inter-relation of rainfall, evaporation, and run-off. Estimates of the quantities afforded under conditions prevailing in New England are given in the following table, in which part of the figures are the estimates of the New York Commission on Additional Water Supply, based on extended and detailed studies on Long Island in 1903.

Yield of Isolated Areas of Sands and Gravels

Rainfall. (Inches.)	Estimated Evaporation. (Inches.)	Estimated Run-off as Flood Flow. (Inches.)	Estimated Ground-water Increment. (Inches.)	Yield per Acre per Day. (Gallons.)	Yield per Minute per Ten-hour day. (Gallons.)
35*	17*	3*	15*	1,116	1.85
37½	17	4	16½	2,228	2.03
40	17	5	18	1,339	2.22
42½*	17*	6*	19½*	1,451	2.41
45	17	7	21	1,562	2.60

The foregoing table shows the limitations of yield where there are no ground water additions from outside sources. Under such conditions the yield is essentially dependent upon area.

Yield of Non-Isolated Areas of Sand and Gravel

When additions from outside the area normally tributary to the wells occur, the supply is largely dependent upon the rate of underflow. The rate of movement in materials of different sizes has been indicated in a table given above. The following table shows the volumes that may be anticipated under varying conditions of porosity and movement.

The figures in the table show the underflows passing given points before pumping has begun. They are the quantities which will normally be available to wells without material readjustment of replenishment conditions.

After the pumps are started, the movement of the water will be greatly accelerated because of the increased gradient resulting from the local lowering of the water table near the well. Moreover, since a heavily pumped well intercepts and utilizes the underflow over a much greater cross section than 1,000 square feet, the supplies actually available at a given point will ordinarily be several if not many times the quantities indicated in the table. The amount and permanancy of the supply that may be withdrawn in excess of the normal underflow will be regulated by the readiness with which replenishment by downward percolation from surface sources occurs. This, as previously indicated, is best determined by combined pumping and underflow tests.

The storage capacities of sands and gravels are very great, and in many instances, even tho the wells may be drawing from them faster than the water is replenished, the supplies may be sufficient to make it possible to postpone for many years the installation of more expensive systems, with their attendant in-

Transmission Thru Sands and Gravels

(Per One Thousand Square Feet of Cross-section.)

Head, 10 feet per Mile; Temperature, 50 degrees F.

Porosity. Per Cent.	Relative Flow.	Flow in Gallons per Minute.
Medium sand.	(Effective size, .4 mm.)	
26	1.00	0.4
28	1.28	0.5
30	1.61	0.6
32	1.99	0.8
34	2.43	1.0
36	2.93	1.2
Coarse sand.	(Effective size, .8mm.)	
26	1.00	1.6
28	1.28	2.1
30	1.61	2.6
32	1.99	3.3
34	2.43	4.0
36	2.93	4.8
Fine gravel.	(Effective size, 2. mm.)	
26	1.00	10.2
28	1.28	13.1
30	1.61	16.4
32	1.99	20.5
34	2.43	24.8
36	2.93	30.0

creased cost of maintenance and higher interest charges. The following table shows the available supplies in materials of varying porosities after the necessary deductions for compacting and residual moisture have been made. The compacting and residual moisture factors are based on experiments made for the writer by L. B. Cheminant in the laboratories of the Department of Public Works of San Francisco in connection with ground-water investigations for that city.

Storage in Sands and Gravels

(Gallons per One Thousand Cubic Feet.)

Porosity by Laboratory Test. Pct.	Probable Porosity of Undistributed Material. Pct.	Deductions for Residual Moisture. Pct.	Available Porosity or Storage Cacacity. Pct.	Storage in Gallons per 1,000 cu. ft.
Very fine sand (approaching silt).				
30	30	25	5	374
30	30	20	10	748
35	30	25	5	374
35	30	20	10	748
40	35	25	10	748
40	35	20	15	1,122
Fine sand.				
30	30	15	15	1,122
35	30	15	15	1,122
40	35	10	29	1,496
Medium sand.				
30	30	10	20	1,496
35	30	10	20	1,496
40	35	10	25	1,870
Coarse sand.				
30	30	7	23	1,720
35	30	7	23	1,720
40	32	7	25	1,870
Gravel (mixed with sand).				
20	16	6	10	748
25	21	5	16	1,197
30	25	5	20	1,496
35	27	4	22	1,646

Applying the figures of the above table to a larger area, we find that a tract of sandy deposits one square mile in extent with an average depth of saturation of 50 feet and an available yield of 15 per cent. should afford about 1,564,000,000 gallons, or enough to supply a million gallons a day for 1,564 days, or nearly 4½ years.

Since, even in deserts, there are practically always more or less additions to the ground-water reservoirs thru replenishment from rainfall or percolation from temporary or permanent streams, the length of time the accumulated storage within the ground may be drawn upon by a water-works system will depend on the difference between such replenishment and the quantity withdrawn rather than on the absolute storage. Since this difference is often slight, at least as compared with the total volume of ground-water reserves, the probable life of a system under such conditions is often sufficient to warrant the installation of relatively expensive and permanent plants.

The following abstract from Mr. Burdick's paper adds some practical details which will make the view of the general subject more complete:

Cities Having Ground Water Supplies

At the present time about one-fourth of our cities exceeding 25,000 population are supplied with ground water and probably a somewhat greater proportion of the smaller cities and villages is supplied from this source. Altho great in number, but few supplies are large in the amount of water developed, Brooklyn leading with a 30,000,000 gallon development. Three or four plants produce 10,000,000 to 15,000,000 gallons daily upon the average; about a dozen pump from 5,000,000 to 10,000,000, and 40 to 50 produce 1,500,000 to 5,000,000 each. Altho no late statistics are available, no doubt the number of smaller towns and villages thus supplied is very large, for small supplies are cheaply developed over a large part of the United tSates.

With but few exceptions the large supplies have grown from small beginnings as the possibilities of the local situations have been demonstrated thru experience. In probably the great majority of cases the reasons for adequacy or inadequacy are but imperfectly understood, resulting often in disappointments in the yield from extensions and expenditures that could have been better directed with fuller knowledge of the general principles involved and the limitations of the local situation.

Most of the cities already supplied are growing rapidly, and many have approached that stage of development where additional wells do not seem adequately to meet requirements; where it seems wise to stop and consider whether further development along the lines of the past is wise, whether further expenditures will be permanently useful, or whether a radical change in the source of supply is not warranted in the light of probable future growth.

These sources being invisible are less easily comprehended than surface water supplies and more difficult of measurement, but with fundamental principles well in mind, coupled with a fair definition of the underground situation, meas-

urements and estimates become possible sufficiently accurate for practical development, and the labor of ascertaining the governing conditions in many cases is not difficult. It frequently consists in making the best use of facts already available in fragmentary form coupled up and supplemented by comprehensive tests and the intelligent consideration of records.

Effect of Development

Almost any practicable ground water development has the effect of changing the natural ground water conditions in that the surface of the ground water is depressed adjacent to the collecting system, thus producing a flow toward the collecting system not only along the path that the ground water formerly took, but also drawing in more or less ground water from all directions even from the downstream side to a greater or less extent, for ground water slopes are usually relatively flat, and the several feet of reduction in head at the collecting system are usually sufficient to produce a slope toward such system from all directions. The larger the draft of water and the deeper that the surface of the ground water is depressed, the larger the area thus influenced.

Most developments are made upon the lowest ground available for the reason that the ground water contours in general follow those of the ground surface, and by locating a collecting system upon the low ground, a larger gathering area is utilized. The low places are also the usual location of the streams, and as these generally occupy their ancient channels there are here usually present the most porous materials, sand and gravel, if any are to be found in the locality. If the bed of the stream cuts into these porous materials as is frequently the case, an outlet for the ground water is formed in the state of nature and when a collecting system is inaugurated an important modification in the natural conditions occurs.

If the ground water in the collecting system is depressed below the surface of the stream, as is usually the case, the collection of the ground water in the vicinity is stimulated, and in addition there is a tendency to reverse the flow of ground water between land and stream, producing an inflow from the stream to the collecting system. There are some situations where this reversal of flow is not present; particularly where the stream flows upon a clay bed overlying the sand or gravel stratum from which the ground water supply is developed.

The rapidity with which the water may enter the ground from the stream obviously depends upon the available head, the coarseness of the material forming the stream bed, and it is also modified by the turbidity of the water and the relative duration of various turbidities; also the velocity of the stream as affecting the amount of deposits.

It is well known that a water filter constantly operated becomes choked and is necessarily cleaned if operations are continued. Precisely this situation exists in the stream beds and it is fortunate for the quality of the ground water that this is so, for it has a tendency to seal rapidly those places where for reasons of high porosity or steep gradient, the filtration rates are most rapid; thus in a way tending to distribute the seepage more uniformly over a larger area.

Altho the stream bottom may become comparatively impervious, such water tightness is comparative only, and the large areas subject to filtration adjacent to the ground water collection system produce considerable water even under adverse conditions.

Fundamentals of Yield

In any collecting system there must be:

1. A gathering ground sufficient to produce the required water; that is, an area sufficient in extent so that the absorbed rainfall made uniform by ground storage and supplemented by infiltration, if any, is sufficient at all times to meet the maximum draft of the collecting system.

2. That the location, character and depth of the impervious materials between the gathering ground and the collection system are such as to permit the passage of ground water at the rates demanded.

3. That the collecting system is so designed that the maximum rate of draft can be secured under the most unfavorable ground water levels that are likely to occur.

If any one of these three requisites is lacking, the supply must of necessity be measured by the weakest link in the chain.

In planning new developments or in materially increasing old ones, it is wise to select locations where present demands can be accommodated, and wherever possible, a large margin left for future demands, and it is further unwise to attempt to develop a gathering ground too closely to its estimated capacity. A factor of safety should be allowed in amount depending upon the accuracy with which the underground conditions are determined.

Available Supply

Experience seems to indicate that under reasonably favorable conditions, from one-quarter to one-half of the rainfall may be depended upon to replenish the

ground water. This experience is in well watered country, in localities favorable to ground water use. A local index is furnished by the low water flow of certain streams, particularly brooks or other water courses having a drainage area approximately coincident with that practicable for ground water development. In some situations the geological conditions may be uniform over a comparatively large area as in certain regions where the glacial work has been uniform. In such localities the minimum stream flow is a good index.

The following table indicates the approximate absorption capacity of several underground water sheds where capacity has been demonstrated by usage:

Relation Between Rainfall and Ground Water

Place.	Mean Annual Rainfall Inches.	Inches Ground Water Collected.	Ratio Ground Water to Rainfall.
Long Island	45	14 to 24	30% to 50%
Holland, Europe	26	8 to 13	30% to 50%
*Holland, Michigan	34	8.72	26%
Philadelphia, Pennsylvania	43	5 to 8	12% to 18%
*Jeffersonville, Indiana	45	3.6	8%

Note:
12 inches per year collected=570,000 gallons day per square mile.
8 inches per year collected=380,000 gallons day per square mile.
6 inches per year collected=285,000 gallons day per square mile.
* Watersheds observed not fully developed.

Transmission Capacity

In addition to a gathering ground and an ample collecting system, there must of necessity be present coarse materials of such nature and extent that water may travel from its source to place of collection. Sand and gravel is the only transmission medium of significance in municipal water supply. It has been demonstrated that the flow thru such materials departs from the law of flow thru pipes and follows more nearly that thru capillary tubes. The flow in sand and gravel at the velocities occurring in the ground varies with the first power of the head or slope. This law is evidenced by the practicable draft from the wells which increases in direct proportion to the amount that the water surface in the well is lowered thru pumping.

The capacity of a given material depends upon its porosity and to a large extent upon its coarseness, it having been demonstrated that the velocity of flow under a given head varies approximately as the square of the effective size of the grains in the material.

Thru the investigations, formulae and coefficients developed by Darcy, Krober, Hazen and Slichter, and particularly the application of these investigations to practical ground water problems as clearly outlined by Prof. F. E. Turneaure, it is practicable where the conditions are well defined and fairly uniform to approximate the capacity of the water transmission medium, and such computations are frequently of great use not only in ascertaining whether it is practicable to draw a stated quantity to a desired locality, but also in the design of the means for collecting the ground water.

The formula suggested by Professor Turneaure is a simplification of a formula of Hazen by the elimination of the temperature coefficient, as most ground waters have about the same temperature, and embodying all variables except slope in a coefficient which is varied to allow for the effective size of the sand and its porosity. The effect of porosity is based on investigations by Slichter.

The formula is quite simple, velocity in feet per day being equivalent to the product of the slope of the ground water hydraulic gradient and a coefficient, selected from tables, based on effective size and porosity. Knowing velocity and porosity, which represents the void space open to the travel of water, quantity can be computed from the dimensions of the water bearing stratum.

The important effect of "coarseness" is well illustrated by the following table prepared from Professor Turneaure's value for a porosity of 30 per cent.

0.10	Very fine sand	43
0.20	Fine sand	171
0.30	Medium sand	384
0.40	Coarse sand	681
0.50	Torpedo sand	1,066
1.00	Fine gravel	4,260
2.00	1/10 inch gravel	17,050
3.00	1/6 inch gravel	38,400

It should be noted that the effective size as stated refers to the smallest 10 per cent. of a given sample, according to the definition of Hazen; the small grains, tending to clog the interstices, having a governing effect.

The relation of flow to size in the above table indicates that under any given slope one foot of torpedo sand will transmit as much water as 25 feet of very fine sand, and 1 foot of fine gravel (size 1.0 m.m.) is approximately equivalent to 100 feet of very fine sand.

It is, therefore, the coarser materials only that are of much significance in a large water collecting system, and frequently the finer sands may be neglected or given nominal values without materially affecting the problem in hand.

Where the underground conditions are known as to depth and character of water bearing material, it is practicable to demonstrate the value of the flow coefficient by pumping a test well and observing the hydraulic gradient of the ground water. In several cases where the effective size of the water bearing material has been noted thru the sifting of numerous borings, the coefficients tabulated above have been approximated. If the purpose in hand requires an approach to accuracy, such tests of the water bearing materials in their original situation are necessary; and the coefficients thus developed eliminate inaccuracies in a number of other determinations in that the reasoning is then direct from quantity drawn to hydraulic gradient.

Knox Automobile Fire Apparatus

The widespread publicity gained from their first successful installations of motor fire apparatus in Springfield, Mass., described in a recent number of MUNICIPAL ENGINEERING, brought a large number of orders to the company, particularly from New England and adjoining states, with the results that this branch of the company's business was soon in a flourishing condition and has remained one of its most important assets ever since.

The Knox Co. is now manufacturing a very complete line of motor-driven fire apparatus, covering pumps of both piston and rotary types, combination and protective cars, hook and ladder trucks and tractors for hauling steam engines, hook and ladder trucks or other heavy kinds of apparatus.

This company has always believed in the policy of building fire apparatus of extra strong construction rather than using a touring car chassis slightly strengthened in vital parts, realizing that the strains to which this class of automobiles are subjected call for the utmost strength to maintain absolute reliability. deep channel steel frames and very robust axles, transmissions and steering gears.

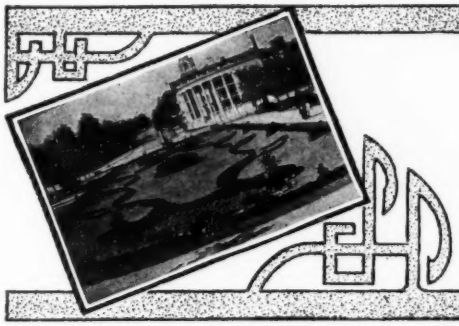
A good illustration of the value of this type of construction is shown in the following experience which a Knox combination car passed thru in Coeur d'Alene, Idaho, a short time ago.

While on its way to a fire this machine skidded in turning a corner on wet All its models are therefore fitted with asphalt and was not stopped until it had cut off a telegraph pole 12 inches in diameter with the front bumper on the frame. It was able to continue on its way to the fire, however, and back to the engine house on its own power, being apparently none the worse for its encounter, with the exception of broken lamps, bent mud guards and a slightly dented radiator.

The standard type of combination car built by the Knox Co. is fitted with a 48-h.p. four-cylinder motor which has a large reserve power factor and is capable of driving these cars as high as 50 miles per hour, with full equipment. Single or double chemical tanks can be carried, and space is also provided for carrying 1,200 feet of 2½-inch water hose, as well as twelve men and full equipment of fire tools, etc.

The most promising model the Knox Co. has built is a new 600-gallon triple combination, pump, hose and and chemical car, fitted with a rotary pump and driven by a 60-h.p. six-cylinder motor of large reserve power. The pump on this machine is arranged with a special device for taking up wear on the blades, making it possible to keep it working on a high efficiency, even after continued service. One thousand feet of 2½-inch water hose can be carried on this car, together with ten men and equipment, making it virtually a complete fire department in itself. As this type of machine is much lighter than the piston type and can throw as high as 750 gallons of water per minute maximum, it has found favor with a great many towns and cities where good speed and hill-climbing ability, combined with moderate capacity, are required.

In the Knox-Martin tractor the company has a type of machine which is adaptable to a wide variety of purposes and one which is meeting with an extensive sale, as it can be applied readily to present horse-driven apparatus by merely connecting the rear springs of the tractor to the front axle of the apparatus and putting sprockets on the front wheels. Large size steam engines or hook and ladder trucks can be drawn with this machine at a speed of twenty-five miles per hour, and if used in connection with motor-driven hose cars can thus be brought to a fire in season to be used without loss of valuable time.



CIVIC BEAUTY

St. Louis Plans a Central Traffic Parkway

The St. Louis City Plan Commission, which came into existence two years ago, has made its report to the Municipal Assembly on the plan to establish a great central traffic parkway two miles in length, extending from Twelfth street to Grand avenue. This plan, carried out, would call for the acquisition of property lying between Market and Chestnut streets, a strip one block wide.

The City Plan Commission was created by ordinance and is composed of fifteen members. The duties of the body are as follows:

First. To prepare a comprehensive city plan for the future improvement, as well as for the commercial development of the city, including recommendations for:

(a) Improvement of the river front.
(b) Extension of streets and the supervision of the opening of sub-divisions.
(c) Improvement of surroundings of Union Station.
(d) A system of widening and opening various thru streets so as to make the city more cohesive and less disjointed.
(e) Control of nuisances.
(f) A playground, park and boulevard system.
(g) Location of public buildings.
(h) Encouraging the location of manufacturing establishments in designated districts.
(i) Extension of conduit district for wires.
(j) Extension of granitoid sidewalk districts, and for the regulation of same in the residence districts so as to provide for the planting of trees and for sufficient soil space to assure their growth.
(k) Such other improvements as will tend to make St. Louis a greater and more beautiful city.

Second. To suggest the state and municipal legislation necessary to carry out the recommendations of the commission.

Traffic Parkway

The commission's report to the Assembly says in part:

"This initial traffic parkway from Twelfth street to Jefferson avenue is the initial step in the planning for a greater and better St. Louis. If approved, it will be followed naturally by extension westward from Jefferson avenue to Grand avenue.

"The best city planning is that which permits traffic to pass from any point to any other point in a city by the most direct and expeditious routes. Judged by such definition, St. Louis today is not well planned. The traffic parkway from Twelfth street to Grand avenue will become a main artery of travel east and west. It will be supplemented by connecting radial thoroughfares which will make the city cohesive."

In discussing the value of property in the vicinity of the proposed traffic parkway, the report states:

"In the vicinity of Olive and Twelfth streets (two blocks north of the eastern end of the proposed thorfare) values range from $1,000 a front foot upwards. About the intersection of Grand avenue and Olive street values have climbed to similar figures. Between these two centers of high priced and rising property lies a strip two miles long and half a mile wide. Three-fourths of the property embraced in that strip is not worth as much as it was twenty years ago. A considerable portion would not sell today for the prices realized thirty years ago; and some of it has dropped below the value of forty years ago. The depreciation in many blocks has carried this property downward to one-third and one-half of what it was considered worth by a former generation. Rentals have been reduced to fractions of what the improved property once yielded. Four-fifths of the buildings have been allowed to deteriorate. Hundreds of these buildings are now untenanted. A thousand of them yield the owners only nominal revenue.

"And yet this strip is the geographi-

cal center of St. Louis. Its gently undulating topography is ideal for the best city growth. This 'blighted district' fronts upon the main gateway into the city. Lengthwise thru it run the chief lines of travel between the business center and the residence sections.

"St. Louis has suffered severely from the shifting of values. The city has seen the leading commercial thoroughfares of one generation become the depreciated and half deserted avenues of another. The palatial homes of one generation have become the rooming houses of the next.

"St. Louis has ruins east of Fourth street and this long blighted district west of Twelfth street. City planning should aim to steady and make permanent the values of the business district. It should provide for logical commercial growth which will not be at the expense and loss of any other section. It should create great thorofares which will take care of future traffic without the congestion already apparent on downtown streets.

"Looking to such desirable development, the City Plan Commission recommends the acquisition of the blocks between Market and Chestnut streets westward from Twelfth street to Jefferson avenue, for the creation of the central traffic parkway. Present low values of realty encourage immediate action.

"The frontage on Twelfth street between Market and Chestnut streets, is assessed at $1,000 per front foot for the corner of Twelfth and Chestnut, and $1,100 per front foot for the corner of Twelfth and Market. The frontage on Twelfth street between the two corners is assessed at $650 per front foot.

"In the western part of the block, extending to Thirteenth street, the frontage on Chestnut street is assessed at $225, and on Market street at $400. These assessments hold for the two frontages except the corners at Thirteenth street, which are assessed at $350 for the Chestnut street corner and $500 for the Market street corner.

"On Grand avenue, the western terminus of the proposed traffic parkway, the ground between Lawton and Pine streets is assessed at $350 on Pine for the Grand avenue corner and $150 on Lawton for the Grand avenue corner. From both ends of the traffic parkway valuations diminish rapidly. East of Jefferson avenue the ground is assessed as low as $55 per front foot for Chestnut street frontage and as low as $65 per front foot for Chestnut street frontage and as low as $65 per front foot for Market street frontage. West of Jefferson avenue a considerable part of the frontage of Pine street is assessed as low as $35 per front foot, while the assessment of the ground fronting on Lawton avenue between Jefferson and Grand for several blocks runs as low as $30 per front foot.

"The valuations of improvements in the blocks within the limits of the proposed traffic parkway show the same tendency downward. Between Twelfth street and Jefferson avenue, Market and Chestnut streets, there is only one block on which the improvements are rated by the assessor at over $100,000. That is the block between Eighteenth and Nineteenth, Market and Chestnut streets, opposite Union Station. The principal structures are hotels. The total valuation of the improvements of the entire block is $116,800. The improvements of the block between Sixteenth and Seventeenth, Market and Chestnut, are valued at only $41,800. The valuations of improvements on the other blocks range from $45,000 to $100,000.

"The total valuation of all the improvements in the twelve blocks from Twelfth street to Jefferson avenue, comprehended in the recommended plan for the traffic parkway, is $840,950, an average of only $70,000 to the block. For the entire 21 blocks between Twelfth street and Grand avenue the valuation of the improvements is placed by the assessor at only $1,656,050.

Five Plans for Development

"Five tentative plans before the commission illustrate the possible development of this traffic parkway. The blocks between Market and Chestnut streets are narrow from north to south as compared with other St. Louis city blocks. Lots fronting on these streets are only 81 feet deep in the block from Twelfth to Thirteenth street. West of Thirteenth street the lots are from 72 feet to 73 feet 5 inches in depth. This shallow condition prevails to Jefferson avenue.

"The condemnation of the blocks would give the city for the proposed traffic parkway a space of 287 feet width from the north side of Chestnut street to the south side of Market street. The tentative plans contemplate a division of this space into sidewalks, two trafficways, two spaces for street car tracks, two narrow parks and a central boulevard.

"The tentative plans differ chiefly in the proposed width of the sub-divisions. One of the plans gives the sidewalks along the property line of Chestnut and Market streets a width of 10 feet. Next to the sidewalk is allowed a space of 10 feet for grass and trees. The trafficways are 45 feet in width, this space including the two reservations for the car tracks, which are located along the south side of the Chestnut street traffic-way and along the north side of the Market street traffic-way. Next to the car track reservations are the strips of parking,

each having a width of about 55 feet. This width is divided to provide for a lawn of 30 feet, with two rows of trees, bordered by walks 12 feet wide. Between the two strips of parking is a boulevard 50 feet in width.

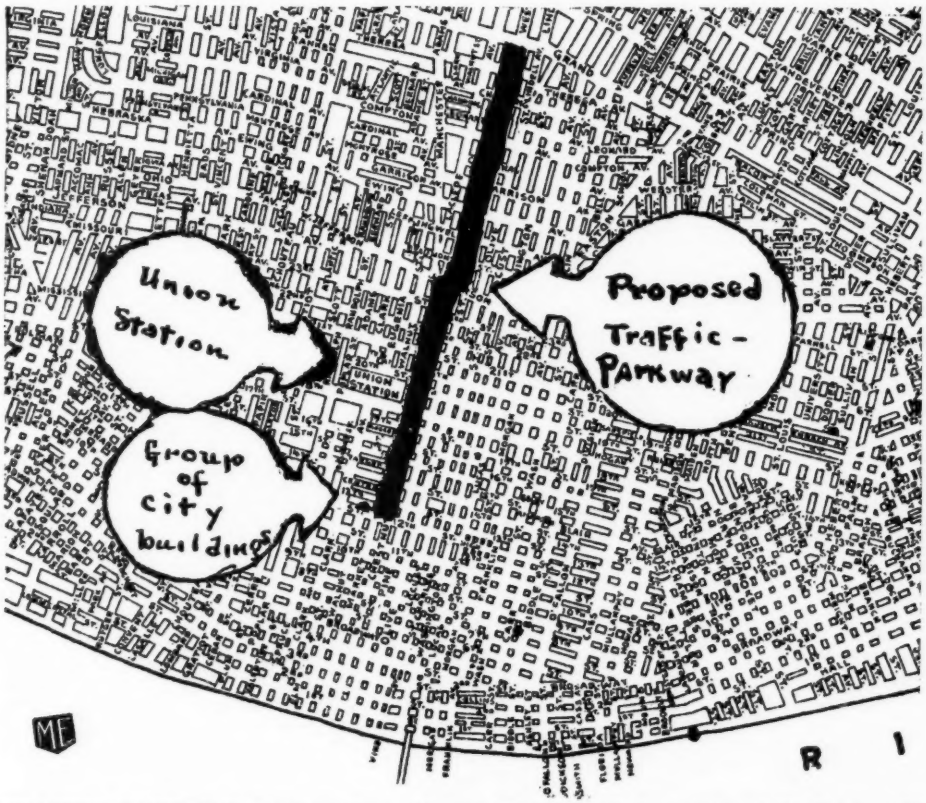
"The traffic-ways are for business and slow-moving vehicles. The boulevard is intended for fast-moving light vehicles. Along the street car reservations are walks bordering on the strips of lawn. This tentative plan is Proposition A.

"Proposition B varies from Proposition A in that it offers a different arrangement of the walks in the parking, so that one walk passes between and underneath the double row of trees. The space allowed between the rows of trees is 20 feet. The park width, including the walk beneath the trees is 53 feet 6 inches. The traffic-ways in Proposition B are 45 feet, the same as in Proposition A.

"Proposition C proposes to make the walks on the Chestnut and Market street frontages 16 feet wide and narrows the traffic-ways to 36 feet, placing the street car tracks within the parking in such manner that only the rails show above the grass. This plan would give for the parking, which includes the street car track space and the walk on either side of the double row of trees, a greater width than suggested in the other propositions.

"Proposition D also suggests the placing of the car tracks in the parking and covering all but the rails with grass. It allows 16 feet for the Chestnut and Market street walks, and gives the driveways a clear width without street car interference of 36 feet. It provides for two rows of trees in each strip of parking on either side of the boulevard, and for a row of trees between the sidewalks and the traffic-ways.

"Proposition E illustrates the possibilities of a subway underneath the traffic parkway at minimum cost for construction and with no damage to abutting property. The removal of the car tracks



TRAFFIC PARKWAY *location thru old and thickly settled portion of St. Louis will greatly increase value of property. Note central location in a congested but low value district between two higher class areas. A new method of improving a business district.*

and the substitution of a subway would allow, according to this proposition, a width of 66 feet 6 inches for each strip of parking including the sidewalks underneath the trees.

"In the central traffic parkway the night problem of downtown St. Louis will find a solution. The boulevard, 50 feet wide, two miles long, cleared for swift traffic, bordered by trees and grass, provided with seats, amply lighted after dark, will become the most frequented and most popular thoroughfare in all St. Louis.

"In Twelfth street today, St. Louis has a fire guard of inestimable value. No conflagration driven east or west could cross that plaza. In the central traffic parkway St. Louis would possess a like fire guard against flames driven by a north or south wind."

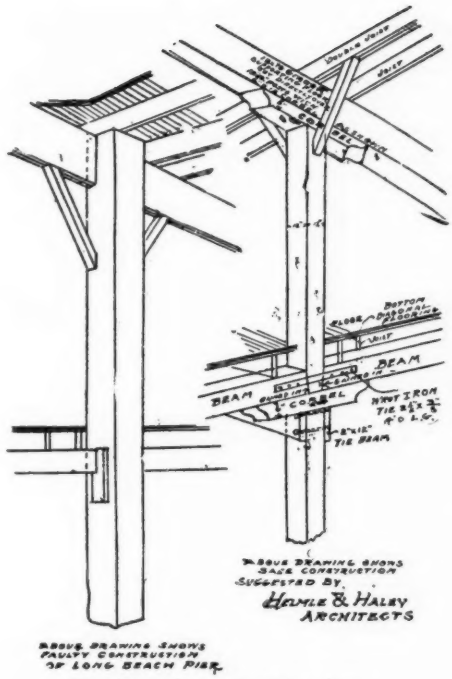
In closing the report, the commission discusses the need for new legislation. "The commission is strongly impressed with the conviction that the city authority in the matter of acquisition of property for park and boulevard purposes should be strengthened and should be more clearly expressed. The commission believes that in such acquisition the power should be conferred on the Municipal Assembly to give the property owner upon whom benefits are assessed the privilege of meeting such assessments in installments, distributed thru such series of years for each case as the assembly in its judgment may deem best.

"The commission urges such legislation as shall divide the cost of the proposed improvements between the adjacent property owners and the whole city on an equitable basis."

Municipal Auditorium Wreck at Long Beach, California

The collapse of the floor of the auditorium at Long Beach, California, resulted in the death of thirty-six persons and the injury of about two hundred. It occurred on May 24, Empire Day, which was celebrated by about 6,000 British subjects and others gathered at the beach. The great crowd was massed upon the upper floor of the Municipal Auditorium, where exercises were to be held, and the doors were foolishly kept closed, so that the weight of the participants was concentrated upon a very small area. The supports of a section of the floor gave way suddenly, dropping upon the lower floor, which in turn caved in, throwing the crowd pell mell upon the sand beneath the building. The structure was of frame construction and its use for large conventions was foolhardy, as the result shows. In addition to its danger of collapse, the building was always a fire menace, as a restaurant was conducted on the lower floor. By happy chance, the wreckage did not catch fire. The work of rescue began promptly and was carried out effectively by the Long Beach

MUNICIPAL AUDITORIUM WRECK *at Long Beach, Cal.*


ABOVE DRAWING SHOWS FAULTY CONSTRUCTION OF LONG BEACH PIER
ABOVE DRAWING SHOWS SAFE CONSTRUCTION SUGGESTED BY
HEMPLE & HALEY ARCHITECTS

How it was: how it should have been.

police, while the mayor of Los Angeles sent quick aid in a special train. Police, nurses and surgeons being hurried to the assistance.

The liability of the city will doubtless be tested in the courts and it is stated that damage suits for about a million dollars for deaths and injuries may result. The grand jury is now probing the causes of the disaster, and the general opinion is that the building was allowed to deteriorate from dry rot and the corroding effects of salt water. It is also claimed that the building was of too light construction and improperly built to hold the weight of the vast throngs which participated in frequent conventions, etc. The accompanying drawing compares the actual construction, as shown by the photograph, with a proper design. The structure will doubtless be torn down to make way for a modern, fireproof and solidly built auditorium.

Waste Heat Utilized by British Municipality

West Hartlepool, an important city on the English northeast coast, can claim to be the first municipal authority to produce electricity by means of waste heat from a manufacturing plant. It will open its new generating station in the course of two or three weeks.

The town since it first began to make its own electricity has relied upon a generating station of the ordinary type, with coal firing. The new station will possess twice the capacity of the old, and its two turbo-generators, each of 1,500 kilowatts will be driven by exhaust steam from the furnace blowing engines of the Seaton Carew Iron Company, adjacent to whose works the station is built. In return for their exhaust steam, which has hitherto been blowing to waste in the air, the Seaton Carew Iron Company will receive free from the corporation's new generating station the supply of electric current that they need at their works.

When the new station is in operation the corporation will be able to produce electricity at a relatively cheap rate, for the expenditure on coal, which is the chief cost in generating current by the ordinary system, will practically be eliminated. The coal bill for the present electricity station is about $20,000 a year, and, as it is anticipated that the consumption of current will largely increase under the new conditions, the ultimate saving of coal by the use of waste heat will be very considerable.

The new turbines are so constructed as to be able to work either with exhaust steam or with high-pressure steam, and, in addition to the pipe which conveys the exhaust steam to them, a high-pressure steam pipe connects them with the Seaton Carew Iron Company's battery of boilers. Thus, should the supply of exhaust steam not be available, either thru a breakdown of the blowing engines or thru the iron works being idle, a supply of high-pressure steam will be obtainable and the output of current from the power station maintained.

The exhaust steam, after leaving the turbines will be condensed, and the water will pass thru a Lea Recorder back to the boilers of the ironworks. To supply the condensers with cold water three cooling towers have been erected, each capable of cooling 115,000 gallons of water per hour.

The total expenditure involved in connection with the new scheme is $193,975 the plant alone having cost $150,000. The old generating station will be maintained as a stand-by, and also as a town sub-station. The current from the new station will be conveyed to the sub-station by means of high-tension cables, and it will be transformed there to the voltage required for distribution to the town. Several large works will take their supply of electricity from the corporation, and the tramways, which are now the property of the town, will in due course be supplied with current from the town sub-station.

PERSONAL

Karl M. Mitchell, Business Manager, River Forest, Ill.

Karl M. Mitchell, who has been selected by the village of River Forest to act as its general manager, resides at 3827 Van Buren street. He was selected from a field of seventy applicants from twelve different states. Mr. Mitchell's appointment is for one year and appointment was made by John E. Adams, president

KARL M. MITCHELL, *business manager of River Forest, Ill.*

of the village, with the approval of the trustees.

"Out of the seventy applications received following the publicity given in the Chicago papers," said Mr. Adams, "there were about forty who appeared to be good men. I spent my mornings, evenings, and Sundays visiting all these that I could. I finally sifted down the most desirable applicants to four men. I told the board I would appoint the one that it approved. We had a little social gathering at which the four men and the trustees were present. A vote was taken afterward and Mr. Mitchell was selected. He appeared to have the best qualifications and the personality necessary for the position. All the members of the board of trustees are employed in Chicago and we felt that it was for the best interests of the village that we have a man always on the job in River Forest."

Mr. Mitchell is a graduate of the Chicago Manual Training school and is thirty-five years of age. He supplemented the theoretical and practical training received at the school by three year electrical course at the Y. M. C. A., one year in the railway organization at the University of Chicago, and three years in finance at Northwestern University, Evanston, Illinois.

Mr. Mitchell was connected with the Chicago Telephone Company for a period of sixteen years, the last five of which he served as division wire chief, chief installation superintendent and also as efficiency expert, doing considerable reorganization work and routine revision. During the past year he has been in business for himself.

River Forest is one of the most handsome residential suburbs in and about Chicago. In his new position Mr. Mitchell will have charge for the village board of all work save that pertaining to schools.

Personal Notes

Delos F. Wilcox, having resigned his office as a Public Service Commissioner for the First district of New York, has opened offices at 1008 Bennett building, 93 Nassau street, New York, for practice as a consulting franchise and public utility expert.

Edwin C. Powell, of Springfield, Mass., carries the idea of the Lincoln memorial highway still farther by laying out a series of five east and west highways, and

five north and south highways as national memorial highways. The names proposed are the Washington Lincoln highway from Boston to San Francisco, the Lewis-Clark and Northwest from Chicago to Tacoma, the National Road and Sante Fe Trail from Washington to San Diego, the Houston-Jefferson from St. Augustine to Phoenix, the Whitman-Alamo from Seattle to Galveston; the Greene-Bagley along the east coast, the Grant-Lee from Erie to Mobile, the Logan-Jackson from Chicago to New Orleans, the Meridian from Winnipeg to Galveston, and the Pacific boulevard along the west coast.

James C. Harding, consulting engineer, has opened an office at 170 Broadway, New York City. Mr. Harding has been engaged in the practice of hydraulic and sanitary engineering for the past twenty-one years and has been a member of the firm of George W. Fuller for the last two years.

Nathan C. Grover has been appointed chief hydraulic engineer of the water-resources branch of the U. S. Geological Survey, to succeed Marshall O. Leighton, who resigned to plan and supervise land drainage in Florida.

Frank W. Buffum, of Louisiana, has been appointed State Highway Commissioner of Missouri at a salary of $3,000 per annum.

Frank T. Townsend, Assoc. M. Am. Soc. C. E., recently Assistant Engineer, New York State Highway Department, has been appointed Assistant Engineer of the Inspection Department of the Dunn Wire-Cut-Lug Brick Co., Conneaut, Ohio. Mr. Townsend is a graduate of Rensselaer Polytechnic Institute, class of 1904, and has been with the New York State Highway Department for the past five years.

I. J. Crowley, E. A. Clark and James X. Gunning, of Chicago, are the Engineering Construction Company, Inc., designing and constructing civil engineering works of various kinds with offices at 106 North La Salle street.

E. Holland has been appointed city engineer at Guelph, Ont.

Louis D. Kelsey has been appointed city engineer of Aberdeen, Wash.

Louis Wyman, of Silverton, Colo., has been appointed state road inspector of Colorado.

Charles B. Buerger has joined the staff of Mr. George W. Fuller, 170 Broadway, New York City. Mr. Buerger entered the service of the Bureau of Filtration at Philadelphia in 1906 as a mechanical engineer and was engaged upon the design, construction, and testing of pumping stations and equipment. Later he was on the design of the preliminary filters at Torresdale and Belmont and had charge of the design of the Queen Lane filter plant. For the past two years he was senior assistant engineer in the filtration division of the Department of Water Supply in New York City on the design of the Jerome Park filter plant.

Walter W. Curtis, M. Am. Soc. C. E., Consulting Engineer, Chicago, Ill., has discontinued his Chicago office to take charge as president of the Curtis Coal Mining Co., Colorado Springs, Colo. He will continue, however, to devote a portion of his time to private engineering practice, with headquarters at 1015 North Nevada avenue, Colorado Springs.

Edwin Thacher and William Mueser have dissolved the partnership of the Concrete-Steel Engineering Co., 21 Park Row, New York City. Mr. Mueser will continue the business under the former copartnership name, and Mr. Thacher will engage in private practice as a consulting engineer with offices in the same building.

C. G. Elliott, M. Am. Soc. C. E., has resigned as Chief of Drainage Investigations, United States Department of Agriculture, and will devote his time to private practice, with offices in the McLachlen Bldg., 10th and G Sts., Washington, D. C.

Arthur H. Blanchard, M. Am. Soc. C. E., professor of Highway Engineering in Columbia University, sailed on June 12th to attend the Third International Road Congress, London. Professor Blanchard is a United States Reporter on Question 3, "Construction of Macadamized Roads Bound with Tarry, Bituminous or Asphaltic Materials," and Communication 10, "Terminology Adopted or to be Adopted in Each Country Relating to Road Construction and Maintenance." He has been appointed a delegate to the Congress by Columbia University, the American Society of Civil Engineers, the National Highways Association and the American Road Builders' Association.

R. J. W. Worcester is superintendent of roads and bridges for the town of Concord, Mass.

Technical Associations

The Colorado Association of Members of the American Society of Civil Engineers has elected G. N. Houston, president; A. O. Ridgeway, vice-president, and R. W. Toll, 700 Tramway building, Denver, secretary-treasurer.

The convention of the Nebraska Cement Users' Association and the Mid-West cement show will be held in Omaha, Neb., between January 30 and February 4, 1914.

The municipal convention of the American Water Works Association is in session as this number of MUNICIPAL ENGINEERING is on the press. Abstracts of some of the interesting papers presented will be found in this and subsequent numbers. The early interest in the convention insured its success.

The third American Road Congress un-

der the auspices of the American Highway Association, the American Automobile Association and the National Association of Road Machinery and Material Manufacturers, will be held at Detroit, the week of September 29, 1913. The meeting of the Michigan State Good Roads Association with 15,000 members and the Ontario Good Roads Association will be held in conjunction with the Congress. An exhibition of road building methods, machinery, materials and results will be held. Logan Waller Page, Director of the U. S. office of Public Roads, is president, and J. E. Pennybacker, Colorado building, Washington, D. C., is secretary.

A large American delegation attended the International Road Congress held in London, Eng., June 23 to 28. About twenty-five of the papers presented are by American authors.

The American Road Builders' Association will hold its annual convention, congress and exhibition at Philadelphia, December 9 to 12, 1913. Samuel Hill is president and E. L. Powers is secretary.

The seventh Chicago cement show will be held in the Coliseum February 12 to 21, 1914. First allotment of space will be made to exhibitors on July 29. In addition to the cement users' association meetings there will be a national conference on concrete road building.

The Anglo-American exposition will be held in London, England, May to October, 1914, to celebrate the centenary of peace and progress in the arts, sciences and industries of the United States of America and the British Empire.

In connection with the Panama Pacific International exposition to be held in San Francisco in 1915 an International Engineering Congress will be held under the auspices of five national engineering societies, the American Societies of Civil and of Mechanical Engineers, the American Institutes of Mining and of Electrical Engineers and the Society of Naval Architects and Marine Engineers. Representatives of these societies are members of the committee on participation and local engineers have been appointed to the various organization committees by W. F. Durand, chairman of the executive committee. W. A. Cattell is secretary and treasurer of the executive committee, with offices in the Foxcroft building, 68 Post street, San Francisco, Cal.

Technical Schools

The April bulletin of the University of Michigan is devoted to the department of engineering, and contains a general announcement of courses in engineering and architecture for 1914 and a full biographical register of the alumni of the engineering department from 1860 to 1912.

The University of Michigan is preparing to establish a bureau for the study of modern municipal problems and collection of material to place at the service of Michigan municipalities. The training of experts to become administrators and specialists in city department work will be a part of the function of the new department.

Harvard University and the Massachusetts Technical Institute have established a new course of study of two years to prepare students for sanitary work. It will be operated by a committee of which Dr. M. J. Rosenau of Harvard Medical School, and Prof. G. C. Whipple, of Harvard University, are members, and Dr. W. T. Sedgwick, of Massachusetts Institute, is chairman. The course will not interfere with the present four-year course in the Institute nor with the two-year course for graduates of medical colleges now offered by the University.

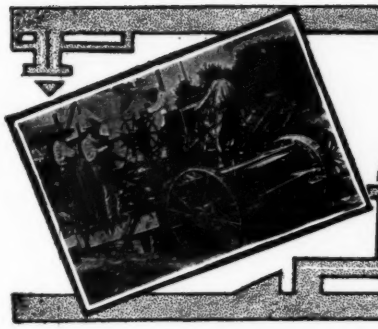
"The Steam Consumption of Locomotive Engines from the Indicator Diagrams," by J. Paul Clayton, has been issued as Bulletin No. 65 of the Engineering Experiment Station of the University of Illinois, which develops and illustrates the application of the logarithmic diagram to locomotive engines. It is shown that the steam consumption of locomotive engines can be determined from the indicator diagrams alone to within 4 per cent. of the actual consumption as measured in test plants.

"The Properties of Saturated and Superheated Ammonia Vapor," by Professor G. A. Goodenough and Mr. W. E. Mosher, has been issued as Bulletin No. 66 of the Engineering Experiment Station of the University of Illinois. It contains two tables of the properties of saturated ammonia and an extensive table of the properties of superheated ammonia. The essential results are embodied in a convenient chart by means of which the usual practical problems of refrigeration may be solved graphically with a minimum of labor and with a satisfactory degree of accuracy.

Civil Service Examinations

The U. S. Civil Service Commission will hold examinations at the usual places as follows:

July 16, 17: Hull draftsman with experience in dredge design in office of Chief of Engineers, U. S. Army, at $1,800 a year.



MACHINERY AND SUPPLIES

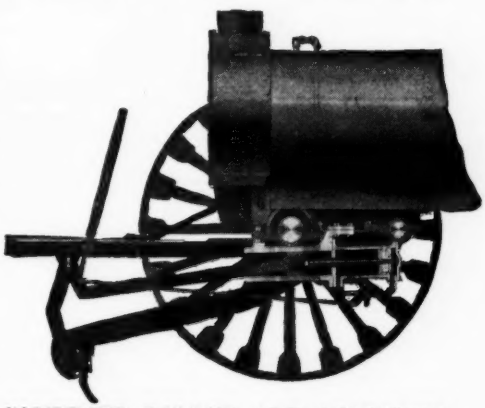
A Roller and Scarifier Combined

"A score of years ago road building was a very simple business," states F. E. Ellis, manager, Essex Trap Rock & Construction Co., Peabody, Mass. "The road contractor then required but little equipment. During the last ten years, however, methods of road building have changed and contractors now face the problem of choosing among multitudinous types and makes of machines for every imaginable purpose.

"Road building has become a business into which one should not enter without considering thoroly the kind and amount of equipment required to do the work that he is contemplating, and only after a careful estimate has been made of the expense of plant and the proportionate charges that should be made for the same upon the work on which he is bidding. One must also realize that once in the business, he must remain in it for many years in order to get back the cost of his equipment, or else be willing to take a loss on the sale of it upon retiring. In other words, it is not a business that a man should enter upon with the idea of it being temporary, but with the idea of permanence. Failure to understand or obey this principle has been disastrous to many contractors. If the proper plant charges are not made, the contractor is deceiving himself just as surely as did the kind old lady who gave gingerbread to all the children in the neighborhood, and thought it did not cost anything because she had everything in the house to make it of.

"The choosing of that equipment which will not only do the greatest amount of work per day but also the greatest variety of work is a most important factor in the business. Contractors now realize that a steam roller which will do all the rolling any roller can do but which also has sufficient power to haul wagon trains and run stationary machinery is greatly to be preferred, as it cuts out necessity of tying up capital in mere hauling engines which can only be used for hauling purposes.

"The Huber road roller and scarifier combined not only takes the place of two machines but can be used as a hauling engine, also as a power plant for the running of stationary machinery. The economical advantages of this type of machine will appeal to contractors making a specialty of road construction. The scarifier is a part of the roller itself. It consists of nine large and heavy



COMBINED ROLLER AND SCARIFIER
showing operating cylinder.

spikes carried in a heavy steel bar which is as long as the extreme width of the roller. This bar is connected with the rear axle and thus all the pulling strain comes on the axle of the roller. The lowering of the spikes into the road is done by means of steam pressure and these spikes are held in place by this same pressure, the depth being regulated by gages at the sides. There is sufficient cushion to the compression so that when solid rock is encountered it gives enough to allow the spikes to slide over the obstruction. These spikes, however, are immediately forced down by the same steam pressure immediately after sliding over the obstruction. The scarifier can be raised or lowered instantly by means of a straight lever, which is placed close to the operator's seat. The

power for the operation of this scarifier is provided for by a simple and independent cylinder placed immediately beneath the boiler. When not scarifying the attachment is carried clear of the ground and does not in any way interfere with the operation of the roller when used for rolling, hauling or stationary plants.

"The grader may be hitched behind roller when scarifying and the surface put in excellent shape for the roller; then the scarifier is raised, the grader removed, and the road rolled and put in as good a shape or better shape than when new.

"One of the special advantages of this combination machine rests in the fact that steam is generated in a boiler of exceedingly large capacity thus having an abundance of power for purposes above mentioned. The rear rolls or drivers give an exceedingly large rolling surface and a strong grip on the ground. These rollers are beveled on the inner edges so as to give proper crown to the finished road. Adjustable scrapers fit closely to both the front and rear of each roll so that no matter whether the engine is traveling backward or forward the surface of the rolls is always kept in a cleanly condition. These combination machines which are furnished by The Huber Mfg. Co., of Marion, Ohio, have a master gear in each rear roller. The Huber also has a spur gear differential, well protected from dust and dirt, thus permitting the transmission of power to each driver at all times and permitting the turning of curves without slipping or side draft."

Use of Steel Curb and Gutter Forms

"Steel curb and gutter forms are rapidly taking the place of wooden forms in curb and gutter construction," state Zittrell & Sullivan, Webster City, Iowa. "They not only lower the cost of construction, but secure absolute uniformity of work.

"We use Heltzel system steel forms, as manufactured by the W. B. Jones Boiler Co., Streator, Ill., having purchased 250 linear feet last season and on June 12 placed an order for 250 feet more with curved corner forms complete; evidence that they are satisfactory. These forms are composed of plates or templates. Rigid side rails are made of annealed steel, pressed to shape in sections of 12-foot lengths, with curvilinear openings in the top flange to receive the division plates at intervals of six feet. These rails are 4, 6, 8 and 12 inches deep with a 2-inch flange on the bottom and a 3-inch flange on top, from which is a depending flange of one inch, and are connected end to end by a sleeve.

"Rigid adjustable side rails 5 feet long are arranged to telescope a part of their full length with the regular side rails. Flexible side rails made in 6, 8, 10 and 12-foot lengths, slotted at intervals of one foot for division plates, are for use in curved sections.

"Division plates ⅛-inch thick and to section length, have tapering slots at their ends to make the forms easy to set up and take down. Directly under each slot in the side rails is stamped a protuberance which serves to engage the division plate firmly with the side rail when placed in position. This device permits the template to be removed without disturbing the side rails.

"Our forms permit of exceedingly rapid removal and resetting and perfect alinement is easily secured. We always have a free top surface to rod off even. The template is removed without disturbing the side rail and it is an easy matter to set up a hundred feet of curb and gutter forms from a hundred feet of sidewalk forms. The rigid rails come in lengths of 6, 9 and 12 ft., whereas the flexible side rails, which telescope the regular rails, are 5 ft. in length and are adjustable from 5 ft. upwards. The curves come in 18-inch radius to fit rails. The Standard curb and gutter forms which we use are 24 by 12 by 6 inches and have 3-inch flanges.

"In the street crossing forms the same side rails are used as those in sidewalk forms and in making up street crossing forms all that is necessary is 6 or 8 division plates. By the use of two telescope rails 6 ft. in length it is an easy matter to set these forms to any width of scope rails 6 ft. in length is an easy matter to set these forms to any width of street. These forms can also be very efficiently used in double rails of blocks and we many times set up forms for an 8-ft. drive with 4-ft. division plates. This type of form particularly appeals to us in view of the fact that the division plates may be removed without disturbing the side rails, also that the self-locking principle of division plates requires no wedges or keys.

"The division plates may be removed by one man without use of hammer and without disturbing the side rails. They are perfectly smooth and have no connecting togle or pit. The side rails are made adjustable so it is a simple matter to set the forms at any odd place without using wood to fill in. Three hundred feet of forms set the base for a big mixer and gang of 20 men and one form setter. With 100 ft. of form it is possible to lay 350 ft. of walk per day."

29th Street, Norwood, Birmingham, Ala. Road Built with "TARVIA X."

The Modern Road Binder

PLAIN macadam roads are adapted to slow horse-drawn traffic. Modern traffic, with its high speed, disintegrates and destroys the ordinary macadam. Its mineral binder cannot resist the thrusts of a driving wheel.

Roads adequate for modern traffic must be bonded with something adhesive, ductile and resisting. Such a binder is Tarvia, a specially prepared coal tar compound which retains its good qualities through all weathers and seasons and holds the stone firmly in place, resisting all classes of modern traffic.

Tarvia is made in three grades:—"Tarvia X" is a very dense material to use as a binder in the large voids of new construction; "Tarvia A" is of thinner consistency for surfacing operations; "Tarvia B" is used cold, can be applied from a sprinkling cart and is sufficiently limpid to percolate into the pores of an old and well compacted road.

"Tarvia X" is required where new construction is called for. "Tarvia A" and "Tarvia B" are used in improving and protecting roads already in use.

A tarviated road or pavement is practically dustless and mudless, and the maintenance cost is, in most cases, so reduced as to more than save the cost of Tarvia treatment.

Booklets on Request.

BARRETT MANUFACTURING COMPANY

TRADE B MARK

New York Chicago Philadelphia Boston St. Louis Kansas City Cleveland
Cincinnati Minneapolis Pittsburgh Seattle Corey, Ala.
The Paterson Mfg. Co., Ltd.—Montreal, Toronto, Winnipeg, Vancouver. St. John, Halifax, Sydney, N. S.

A "Bubble Font" That Is Safe and Saving

The widespread interest being taken in the bubble fountains since the passage of the laws in various states abolishing the public drinking cup, has led to the invention of a number of devices intended to supplant the public drinking cup or rather the public fountain.

Among the numerous fountains that have been brought to the public attention, is one which is anti-freezing, self-closing and absolutely sanitary. This is known as the Murdock "Bubble-Font," and its invention came about in a peculiar way.

"Two summers ago," said the inventor, Mr. Murdock, "I was returning from a few weeks' vacation in northern Michigan. There were quite a number at the railroad station waiting for the train. It was a hot sultry day, and every one of us was simply dead for a drink, and altho

THE MURDOCK "BUBBLE-FONT."

there was a water cooler at the station there was not a single drinking cup in the crowd. Right then and there I determined to invent a public drinking fountain that would be absolutely sanitary, that would be anti-freezing, self-closing and self-draining, and I know that in the Murdock 'Bubble-Font' I have such a device."

Mr. Murdock then showed the writer one of their new Bubble-Fonts which he had installed on the street in front of their establishment at 426-430 Plum street. A few moments spent in noting the ease with which the men, women and children could quench their thirst substantiated all the claims made by the inventor.

In the accompanying illustration is shown an outlined design of this new "Bubble-Font," and the readers' attention is called to some of the following distinctive features. First, this font is anti-freezing, because the valve that operates the inflow of water is located in the ground below the frost line, and the overflow and waste are both conducted into the sewer below the frost line. Second, it is self-closing. The bubble of fresh clear water is formed by pressing the foot pedal, which is located just above the ground, as is shown in the illustration, and as soon as the foot is removed, a strong spring instantly closes the valve. The treadle can be forced down only so far, throwing a stream of water from one inch to an inch and a half high, maintaining a steady flow which does not splash the individual.

Third, this is non-pollutable, as the lips touch only the flowing water. The Murdock font is in no sense a bubbling cup, as there is no cup about it. When the valve is open, the bubble washes all exposed brass parts, so that ink or any liquid maliciously poured into it would flow thru either the bubbling device or the waste into the sewer.

A study of the construction of the bubbler would show that even where ignorance causes a diseased mouth to touch the metal, persons following would not be liable to contagion, because the water flows thru not only the lower aperture, avoiding contact with any exposed surface before expanding into the bubble, but it also washes back over all exposed surfaces, thoroly cleaning them.

It is sanitary because the integral trap at the bottom prevents sewer gases from arising to the drinking point. The Murdock Bubble-Font is made by the Murdock Mfg. and Supply Co., of Cincinnati, and is especially adapted for schools, railway stations, factory yards, parks, and city streets.

Blue Printing Machinery

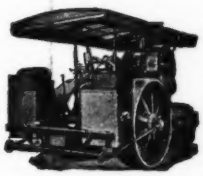
As Used by the Multi-Color Copying Company, Detroit, Michigan.

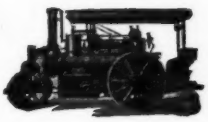
"Our experience with the blue printing machinery has been quite extensive, as we are in the commercial blue-printing

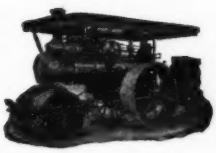
Port Huron Hand Steering Reversible Dump Cars can be pulled in train and—**can be backed in train. Can you back a train of your cars** 2 feet? 2 rods? 2 miles? with only two men?

Can be used where any other cars may be—**and** in **many** places where **others cannot.**

Port Huron
ASK THE USER







The New York-Port Huron "Standard" Road Rollers—2 sizes.

Port Huron General Purpose Road Rollers—4 sizes.

Port Huron Hauling Engines.

The Port Huron All-Steel Hand-Steering, Reversible, Stone Spreading and Dump Cars.

Port Huron All-Steel Stone Spreading and Dump Cars.

New York-Port Huron Scarifiers.

Port Huron Road Making Machinery.

THE PORT HURON LINE

OF HEAVY POWER ROAD BUILDING MACHINERY IS

The Most Complete in the World

STANDARD

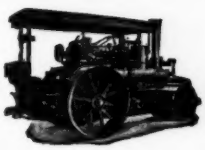
New York - Port Huron Rollers

The ARISTOCRATS

OF THE

Road Roller World

Port Huron
ASK THE USER



Booklet No. 10 will be gladly mailed you on request.

Port Huron Engine & Thresher Co.

PORT HURON, MICHIGAN.

REPRESENTATIVES IN ALL PRINCIPAL CITIES.

business, and we are pleased to give you our experience, considering that it may be of value to municipal engineers now considering the advisability of installing machines in their drafting rooms.

"We have been in the commercial blueprint business almost since its inception and know the different types of machines used, as well as the different systems; also the manufacture of blueprint paper, quite thoroly. At present our plant comprises about 5,000 square feet in the business center of the city of Detroit, and our machinery has been selected only after a thoro comparison and study of all existing makes, in so far as efficiency and service, as well as reliability, are concerned, which are the main features in the successful blueprint establishment.

"We were the first people in Detroit to use electric blueprint machines. That was about ten years ago, and our equipment consisted of one blueprint machine. This machine sufficed for our needs for about three years; then the demand for blueprints increased and our needs were not taken care of by even two of these machines. At that time the first continuous blueprint machines made their appearance, and we tried different makes both of mercury vapor type and arc lamp construction, going even so far as to construct a machine after our own ideas, which did the work well enough but was not as well as a machine which in the meantime, came out, and of which we are at the present time using three in our plant. We refer to the Pease peerless automatic continuous blueprinting, washing, developing and drying machine. This machine is built on the idea of a newspaper printing press, feeding in the tracings on top of a continuous roll of blueprint paper on one end, and developing and drying the exposed prints at the other end of the machine, so that they come out perfectly dried, hardly stretched out of shape, loosly rolled ready for trimming, while the tracings are returned immediately direct to the operator, making it possible to make many copies of the same tracing as easily as making only one at a time. The speed control is positive by an electric rheostat with 60 different speeds, besides a high and low-gear shifting device, and different shades, increasing and decreasing the printing surface of the machine. The speeds range from six linear feet a minute down to as low as a quarter of a foot per minute, giving the operator a chance to control the work absolutely, and while running, change his speed from the very fastest down to the slowest speed required for special positive blueprints, prints, printing from bristol board, etc. We believe that this type of machine is by far the best where there is a daily consumption of more than say 100 yards of blueprint paper, and we believe that its price can be saved within six months after installation.

"We have lately tried girls to operate these machines and have found this a very satisfactory method, particularly as they handle tracings with greater care and are more adept in trimming prints. The cost of operation resolves itself practically to nothing but the amount of current consumed and the cost of the new carbons used, as the machine is built so simply and rigidly that so far there have been no repairs to speak of, altho the first machine has been running now for over two years. Our daily output varies considerably, anywhere between 500 and 1,500 yards of blueprint paper.

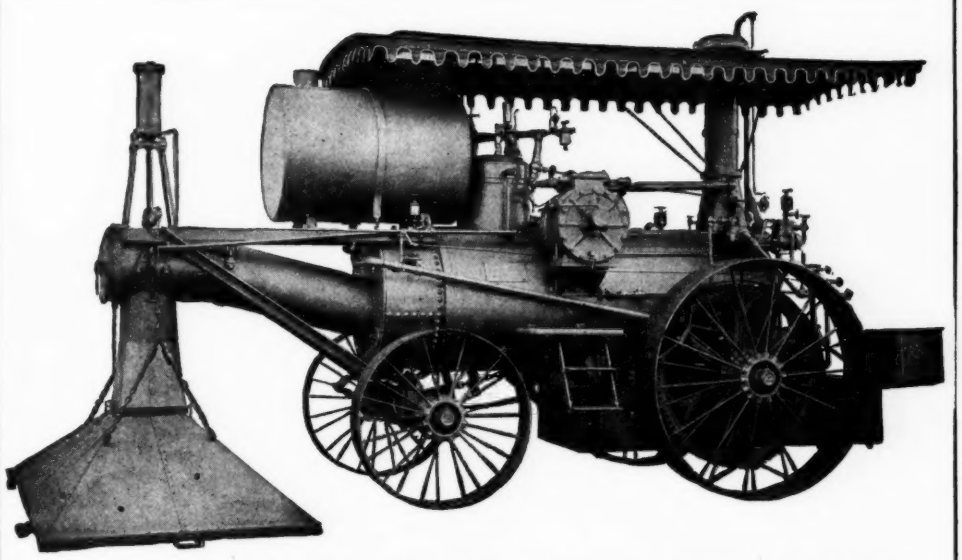
"The celerity of this output is greatly increased by the use of ingenious electric trimming tables as well as hand cutters which we use extensively and which are also operated by girls. Thus we are able to do the work more quickly and much better than we used to by means of scissors. Another great improvement which we are just installing, is the new Pease positive blueline attachment which furnishes us with positive blueline prints made direct from the tracings at the same speed as ordinary blueprints with practically no more care. This class of work is particularly adaptable for map work or where there are changes required later on, as for instance, the addition of plumbing, heating, ventilating, etc., in a building, or any other change in the mechanical drawings, also for forms where only a limited number of prints are required. On account of its simplicity, we find that there is a great demand for this special process.

Staley Tamper Attachments

The Lourie Manufacturing Co., Springfield, Ill., makers of the Staley power tamping machine for the tamping of the back filling in trenches have added several attachments to the machine as will be noted in accompanying photograph.

One of the attachments consists of a diaphragm pump with suction hose for pumping water from trenches. This type of pump is now being furnished for use on those machines sold previous to this late invention, and the Lourie Manufacturing Co. reports that it is in a position to furnish the crank wheel attachment with pitman for connecting pump to the gearing of the tamper.

The spiked head for tamping bar is also furnished for breaking concrete base. Different shaped heads for the tamping bar can be used, such as the



THE LUTZ SURFACE HEATER

——gently heats and softens (without flame) old pavements to same consistency as new material. The temperature of both materials being at the vulcanizing point, when tamped, smoothed and rolled a perfect weld is produced, leaving a finished surface. Instead of having a "patch" the repair becomes a part of the whole.

H. H. SCHMIDT,
(Chief Engineer Borough of Brooklyn, City of New York)
STATES:

"We operate four Lutz Surface Heaters—the resurfacing of asphalt pavements which, through age and wear and tear are beyond ordinary repair, can be most economically done with these machines."

THERE IS ONLY ONE WAY

of repairing, resurfacing and maintaining asphalt and other bituminous pavements, and of cementing asphaltic and other bituminous mixtures on granite, brick, cobble or hard pavements, and that is by means of **The Lutz Surface Heater.**

Illustrated Particulars on Request

Equitable Asphalt Maintenance Co.

Commerce Building. **KANSAS CITY, MO.**

round disc head as shown in the photograph.

The lifting mechanism is very similar to the well known board drop-hammer used for years in drop-forge shops. The mechanism as applied to the power tamping machine is even more simple than the drop-hammer. This lifting mechanism consists of two parallel rolls mounted on shafts running to bearings bolted to the sweeps; the rolls are geared together by spur gears, and are driven by a pinion engaging the gear on the rear roll; the driving shaft runs in bearing bolted to the sweep. The rolls and shaft are kept in line and adjustment by steel tie-rods which pass thru all the bearings and have nuts and lock nuts on each side of each bearing. The front lifting roll is pressed against the lifting board by coiled springs on the tie-rods passing thru the bearings, and are adjustable by nuts and washers. The length of stroke as well as the gripping and releasing of the lifting board is automatically regulated by cutting away a part of the circumference of the lifting rolls, thus the board is automatically gripped, raised and released, once for each revolution of the lifting rolls. The lifting board is of hardwood reinforced with a small steel channel on the edges; the lifting board slides in long steel channel guides riveted to the sweep channels with a heavy gusset-plate, and braced from the top back to the sweep. Mounted in the gusset-plates just above the lifting rods, is a pair of grips or dogs which are connected by a short lever and bell crank; these grips are normally pressed against the lifting board by a coil spring acting on the bell crank, but when the lifting board is in motion the grips are held out of contact with it by a small rod and latch placed near the left hand of the operator. When it is desired to stop the motion of the tamper, the latch is replaced and the grips prevent the board falling, but allow the lifting rolls to raise it the length of the stroke at each revolution; while the board is prevented from rising above a fixed point by reducing the thickness of the board near the lower end. When the reduced section raises to the center of the rolls, they do not grip the board and it thus remains in this position until it is released by the operator.

The Seagrave Pump

By B. K. Black, The Seagrave Company, Columbus, Ohio.

The Seagrave pump is different from the ordinary pump now generally used on fire apparatus. It is neither of the rotary gear nor piston type, but is a multi-stage centrifugal turbine, built along the general lines of the turbine pump, which is rapidly replacing the positive displacement pumps in steam ships, city pumping plants, boiler feed pumps and those used in mines, except that it is more refined and built particularly for fire department work. It is more compact, much lighter in weight and capable of delivering large quantities of water at high pressures.

Our pumps are made in two sizes both of which are entirely of bronze. The 750-gallon size is two-stage; 1,000-gallon size, three-stage. By referring to the line drawing it can be seen that no valves of any kind are required in its operation, not even a relief valve. The water as it comes from the hydrant or cistern enters the intake pipe and then passes into the center of the first stage or impeller around the impeller shaft. This impeller impresses on the water a certain pressure and with this pressure it follows the guides or diffusion vanes which deliver it to the center of the second stage or impeller, which adds more pressure and so on thru all stages of the pump. The pressure given the water by each impeller depends on the speed at which the pump shaft is rotating. It will be noticed that the water travels in a spiral course, all in one direction, and at no time is it forced in an opposite course, as in the piston type of pump; also that the impellers have no reciprocating action, thus obviating all vibration.

All waterways are finished smooth, thereby reducing friction and increasing efficiency. No moving part of the pump touches any other part except where the impeller shaft rests in its bearings at each end, and as these are ball bearings, wear and friction are reduced to a minimum. This is a very important feature because it means that the pump will practically never wear out. And as it cannot be found in any type of rotary gear or piston pump, should be worthy of your careful consideration. The pump is geared up instead of down, as are other makes, thus permitting the use of a slow-speed, long-stroke motor (7¾ by 9 inches), which is the only method by which a dependable motor-pump engine can be successfully operated for long periods without shutting down. The motor delivers its maximum h. p. at 750 r. p. m., and the pump makes 1,500 r. p. m. Compare this engine speed with 1,500 to 2,000 r. p. m. of other makes.

An important feature of this pump is the elimination of relief valves of every kind. Owing to this construction should all lines of hose or gate valves at the pump be shut off at once the pump merely churns the water it contains and the motor accelerates, thus eliminating en-

BAKER ARMORED CONCRETE PAVEMENT

1,249,678 Square Yards Now in Use in Fifty Cities

Wayne County, "The Mother of Concrete Roads," uses Baker Armor Plates exclusively.

THE BAKER SYSTEM OF INSTALLATION

enables the contractor to install steel protected joints in perfect alignment, and to correct grade.

ALL NECESSARY APPARATUS

is furnished with each shipment of armor plates free of charge.

We guarantee Baker Armor Plates to be perfectly crowned as specified, and entirely free from any defects of manufacture.

SPECIFICATIONS FOR BAKER ARMORED CONCRETE PAVEMENT SENT FREE ON REQUEST

THE R. D. BAKER CO.

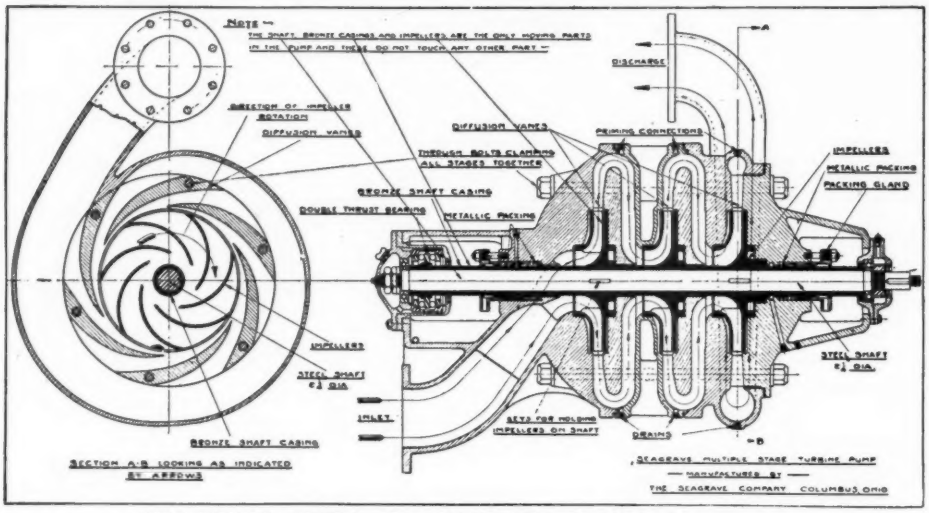
73 Home Bank Bldg. DETROIT, MICH.

tirely all danger of stalling the motor. With all lines shut off and the motor running wide open a pump pressure of 350 pounds is developed, thus outclassing the steam fire engine.

All Seagrave pumping engines are equipped with our automatic regulating device (another important feature not found on any other make of pump), which is operated by the pump pressure and automatically controls the throttle valve on the carburetor so that in case three lines of hose (of any length) are in use and a pressure of 80 pounds is being maintained on all three nozzles, if one nozzle is shut off, the motor is thereby automatically throttled so that only 80 pounds is maintained on the other two lines. The same condition follows should another line be shut off.

A very important feature of the Seagrave pump (and one not found in any other type), is its ability to pump water containing solid matter, such as sand or even rocks whose largest diameter does not exceed ¾ inch without the slightest injury to the pump. Of course, it is not built for gravel-dredging purposes, but will handle such of these as are sometimes encountered in fire department work. This is a decided advantage in cities where drafting from lakes, rivers or cisterns is necessary or where muddy water is to be handled.

As stated above, the multi-stage centrifugal pump is rapidly replacing other types in all lines of work where pumping equipment is required and it is destined to replace the rotary gear and piston type of pump in fire department work; therefore, we ask you to investigate fully the Seagrave pumping engine. Incidentally watch our competitors follow our lead and try to copy this pump, but remember we have the machine perfected; you are taking no chance and the entire outfit is built of Seagrave high quality workmanship and material backed by Seagrave's strong guarantee.



SECTIONAL VIEW OF SEAGRAVE *Multiple Stage Pump.*

The Standard Traction Paving Mixer

By L. A. DeVore.

The Standard Scale & Supply Company are marketing a new type of mixer, specially designed for street paving work and which is known as the Standard traction paving mixer.

This new mixer is furnished with three carts, each cart holding the full capacity of one complete batch. The carts are loaded at the material piles by the shovelers. One man operates the mixer and one man guides the carts. A cable attached to the hoisting drum on the mixer, operated by its own power, draws the carts up the incline and automatically dumps the entire batch. The guider then guides the cart back and hooks the cable to cart number two and goes thru the same operation.

Many contractors who now have this type of machine in operation state that they are able to turn out 1,500 square yards of 4-inch base with less men than heretofore. One contractor states that he has been enabled to eliminate six men thus making a saving from $12.00 to $15.00 a day. "The Standard" sectional distributing trough is made so that every 2 feet may be folded up and

THE HUBER ROAD ROLLER

AND SCARIFIER ATTACHMENT

TWO MACHINES IN ONE

Real Road Building Economy

THE HUBER STEAM ROAD ROLLER

—with its unsurpassed **surplus of traction** power easily hauls graders, scarifiers and long wagon trains, thus eliminating necessity of separate hauling engines.
—Exceptionally strong in the belt, and furnishes most economical power for running of stationary machinery.

THE HUBER SCARIFIER IS

—attached to the rear axle which sustains all the pulling strain—ready for use the instant wanted—carried clear of ground and out of the way when not needed—tears up ground uniformly, regardless of the position of ground wheels—depth regulated by guides at either side—piston working against steam in a simple, independent cylinder gives cushion compression on spikes steam power raises spikes from ground as desired—a single lever operates it either way—works close to curb.

SEND FOR COMPLETE PARTICULARS

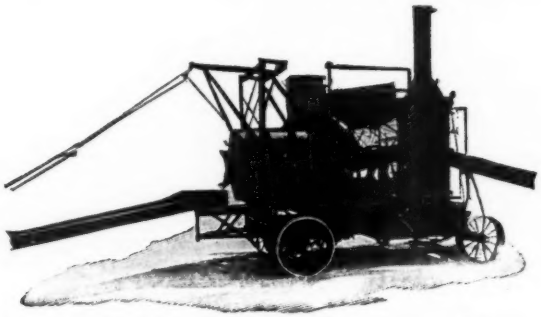
The Huber Manufacturing Co.

601 Center St. MARION, OHIO.

can distribute over a street 50 feet wide up to within 5 feet of outfit without moving.

A leading contractor operating this type of mixer on street paving work, states:

"We have cut our charging labor down to one man and are now using this same labor elsewhere. We use three carts, sometimes four, and in each cart are placed the necessary materials for one complete batch. This is all done at the material pile and it is then pulled to the mixer by a simple hoist with cable attachment, and charged into the mixer by one operation (see illustration). The carts are guided to and from the mixer by only one man. Figure it out yourself that if you saved five men's labor per day at $2.50 each, you would save $12.50 per day, or $287.50 per month of twenty-three working days. This estimate does not include the time saved by rapid charging. The use of a side loader requires several times relaying of the material to charge the mixer while with the cart charger you charge the mixer by only one direct operation.



NEW TYPE *of Standard Traction Paving Mixer.*

Marceline, Mo., Electric Light and Power Plant

The waterworks system was installed here three years ago, G. W. Sturtevant, of Chicago, being the consulting engineer of the work. The total cost was about $55,000.00.

At the time of the completion of the waterworks system, the electric light plant was purchased from the Marceline Electric Light Co., for the sum of $42,000.00, this to be paid in installments of $3,000.00 per year until the sum total is paid.

Within the three years of public ownership the yearly payments have not only been made but several thousand dollars have been spent in improvements and extensions and all from the earnings of the system.

The number of electric light consumers has been more than doubled. The water consumption starting from nothing has had a speedy growth until now about 200 consumers are using water, two of these, the A. T. & S. F. R. R. Co., and the Prairie Oil and Gas Co., being large consumers. About 5,000,000 gallons per day is the present consumption.

Our electrical equipment consists of one 100-k.w. Fort Wayne generator, 3-phase, 2300-volt, 60-cycle, connected to high-speed steam engine; one 62½ k.w. Fort Wayne generator, 3-phase, 2300-volt, 60-cycle, connected to gas producer engine; one 7½ h.p. Fort Wayne motor, 3-phase, used for compressing air for starting producer gas engine; one 50 h.p. Fort Wayne, 3-phase, 2080-volt, induction motor, connected to two double-acting triplex pumps.

L. A. NICKELL, *Superintendent Marceline, Mo., Electric Light and Power Plant.*

S. T. BRYCE J. W. BRYCE, S. D. BRYCE.

PUBLIC AND PRIVATE BUILDINGS
OF ALL KINDS EQUIPPED WITH
Steam Heating by the most Modern Systems.
Hot Water Heating in all its Branches.
Furnace Heating in all its Branches.
Smoke Consuming Soft Coal Self Feeding Furnaces
for Residences.

THE BRYCE HEATING AND VENTILATING CO.
Practical Heating and Ventilating ENGINEERS

Home Phone 25.
Bell Phone 359.

415-16-17-18 THE SPITZER.

Toledo, O. Feb. 24, 1913.

Kewanee Boiler Co.
Kewanee, Ill.

Gentlemen:

We are enclosing herewith a list of some of the public school buildings in which we have, during the past few years, installed steam blast heating and ventilating systems, and in which we have installed as part of the equipment, Kewanee Firebox Boilers

While this list may not be a complete list of all such installations that we have had, we believe that it will indicate to you very clearly our opinion of the merits of the Kewanee Boiler. Our experience justifies us in the belief and in the statement that, for the use to which we place these boilers, there is no other boiler on the market that is at all comparable with tht Firebox in all particulars.

The boilers listed are working under varying pressure ranging from 5 to 40 lbs., and their use has been entirely satisfactory, not only to ourselves, but to our clients in every particular.

While this boiler may not be the cheapest boiler to buy or install as far as first cost is concerned, we believe that when you take into consideration the reasonable price at which it is sold, together with the ease and low cost with which it may be installed and bricked in, and its adaptability to any kind of heating problem, we believe it to be absolutely the best and most satisfactory from the contractor's point of view, at least.

Another point which we regard very highly is the fact that it has a much lower water line than any other of equal merit. We find, also, that in actual operation they have demonstrated greater efficiency on lower fuel cost than any other type of boiler that we have used.

Another reason why we like to figure the Kewanee in our work is because we know that the Kewanee Co. is always there with immediate shipments, which is a great factor on rush work.

We have thrashed out the boiler question with ourselves pretty thoroughly in the last few years, with the result that wherever it is at all possible to do so, we use the Kewanee Firebox Boiler and nothing else. We expect to use more of these boilers during the coming season than in any previous season.

Wishing you a very prosperous year, we are,

Very truly yours,

JWB/A. THE BRYCE HEATING & VENTILATING CO.

KEWANEE BOILER COMPANY
Kewanee, Illinois

Steel Power and Heating Boilers,
Radiators, Tanks & Garbage Burners

Chicago St. Louis New York
Kansas City Salt Lake City

The above motor is set on the extended base of the pump and will carry a 25 per cent. over-load for two hours without excessive heating.

Our rates on electric light are as follows:

Business houses for lighting, 12½c per k.w. hour.

Business houses for motors, 7c per k.w. hour.

Residence houses for lighting, 15c per k.w. hour.

A. T. & S. F. R. R. Co., for lighting, 8c per k.w. hour.

A discount of 10 per cent. is allowed on all business house bills under $5.00, and on all residence bills under $2.50 if paid before the 18th of the month, and 15 per cent. on all business bills over $5.00, and all residence bills over $2.50 if paid before the 18th of the month.

No discount is given on motor bills or the A. T. & S. F. R. R. bills.

The average gross income from the sale of electrical power per month is about $1,000.00 and about $800.00 from the sale of water, at present.

Following is a calculation of the cost of electrical power at the switchboard of the Marceline electric light and power plant, for the months of July, 1912, to December, 1912, inclusive—six months.

1—Total k.w. hr. consumed thru service meters	36,823
2—Total k.w. hr. consumed by flat rates	6,420
3—Total k.w. hr. consumed by water works electric pumps	80,010
4—Total k.w. hr. consumed by street lights, moonlight schedule	10,747
5—Total k.w. hr. consumed by office and power house lights	3,156
6—Total k.w. hr. consumed by transformer losses	9,092
7—Total k.w. hr. consumed in line losses	2,612
Total output	148,860
K.w. hrs. per month	24,800

Operating expenses of electric light plant for months of July, 1912, to December, 1912, inclusive, are as follows:

July	$ 639.02
August	648.20
September	706.28
October	1,049.61
November	965.72
December	956.30
Total	$4,965.13

In the above is included about $800.00 worth of extensions and improvements that would not ordinarily be considered as operating expenses.

Total operating expenses for 6 months	$4,965.13
Insurance on power house, lines, meters, etc.	123.75
Depreciation on same	1,000.00
Total operating expense for 6 months	$6,088.88
Total k.w. hours output, 6 months	148,860
Cost per k.w. hour at switchboard	$0.0409

L. A. NICKELL, Superintendent,
Marceline, Mo.

Elevated Steel Water Tank

By Charles W. Root, City Engineer, City of Lakewood, Ohio.

The city of Lakewood has just completed the construction of an elevated steel water tank for reserve purposes during rush hours, as the 12-inch supply mains leading from the city of Cleveland are not of sufficient size to supply us properly during those periods.

The materials, workmanship and inspection were in conformance to the general specifications for elevated steel tanks and stand-pipes by C. W. Birch-Nord, published by the American Society of Civil Engineers.

Regulator Valves

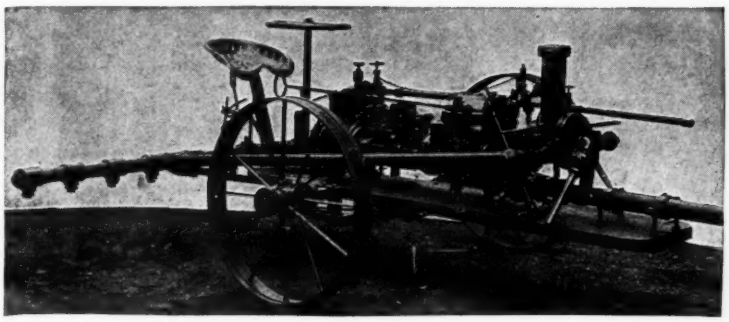
The valve equipment includes one 10-inch and one 6-inch regulator valve. The 10-inch regulator valve, with flanged ends, placed in the 12-inch supply main is adjusted so as to deliver water to the tank and to allow the tank to fill to any predetermined height, and close to prevent further inflow of water. This valve opens whenever pressure in mains is greater than the pressure on the tank side, except that when the tank is full the regulator valve remains closed in order to prevent overflow.

The 6-inch regulator valve with flanged ends is placed in the 6-inch by-pass and is so adjustable as not to deliver water to the tank but to deliver water from the tank at a predetermined point when the pressure drops on the supply main. This valve is also so adjustable that after opening to deliver water from the tank it remains open until the pressure on both sides of the valve is equal, and then closes. Each regulator valve operates within two pounds of the pressure for which it is adjusted.

The water tower is placed on ground the elevation of which above city datum is approximately 112 feet. The elevation of the water surface in tank when filled is approximately 182 feet. The regulator valve is placed at an elevation of approximately 106 feet. When the tank is full the pressure at the balve

DO YOU WANT ROADS THAT ARE

ECONOMICAL **NOISELESS**
DUSTLESS **ODORLESS**
RESILIENT **SANITARY?**



The Johnston Oil and Tar Spraying Machine Builds that Kind

The road which will give the greatest amount of satisfaction at the smallest cost for building and for up-keep is one of which the major portion, composed of broken stone, is held in place by an effective bituminous binder. Satisfactory results, however, cannot be obtained unless the binder is applied in such a way as to insure proper penetration and adhesion; in other words, a good binder may be spoiled through improper handling.

The only way which has so far been found to do this work economically and satisfactorily is by using a machine which will apply the binding material under such a heavy pressure that it is broken up into the most minute particles—or atomized—so that it is spread on the stone like a mist or dew, penetrating the remotest interstices of the stone, and covering each piece of stone on all sides.

The Johnston Oil and Tar Spraying Machine will do this work in the best possible manner at a minimum cost.

Of equal importance with the building of new roads referred to above, is the resurfacing of old worn out macadam roads. These roads can be made as good as new by the application of bitumen in a thin layer, covering this with a layer of grit, and so on with alternate applications of bitumen and grit, or what aptly has been called a "blanket treatment," until the road has been put in far better condition than when it was first built and at an expense which may be considered trifling in comparison with the results secured.

The Johnston Machine has been proven, after a number of years of use, to be the most efficient and economical for this purpose.

It will pay you to write us and let us tell you the advantages of this machine, both as to operation and results.

Contractors' Equipment and Supplies for Highway Work

Kent's Oil Heater and Forcer Unloads road oils or tars from tank cars at rate of 100 gallons per minute without the use of heating coils in the car.

Tank Wagons For road oil or tar. Strongest and most convenient. Equipped with steam pipes for keeping contents liquid when necessary.

Portable Boilers For unloading asphalt or tar from tank cars or for any other purpose where steam is required.

Heating Kettles All sizes and every possible style. The construction is the best and the prices are right.

EVERYTHING THE ROAD CONTRACTOR USES.

LET US QUOTE YOU PRICES.

WM. F. IRISH (Engineers)

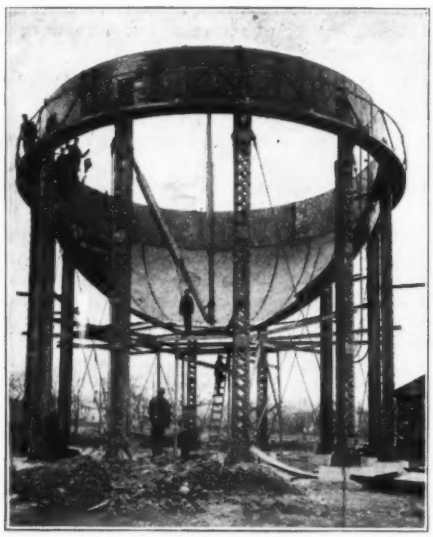
17 Battery Place **NEW YORK CITY.**

Sole Sales Agent for Johnston Sprayers.

will be approximately 33 pounds. The 6-inch regulator valve is intended to be adjusted so as to deliver water from the tank when the pressure on the supply main drops to 20 pounds. Both the 10-inch regulator valve and the 6-inch regulator valve are adjustable to an amount not less than 10 pounds either way from the pressures mentioned.

Purpose of Tower

As before stated, the Lakewood water tower is designed to supply a sufficient quantity of water for the low service district in the city of Lakewood during the hours of greatest consumption from about 3:00 p. m. to 8:00 p. m. daily. This district is now supplied by one 12-inch main, one 10-inch main and one 6-inch main. These mains extend east and west in parallel lines and are each about three miles long, receiving the supply of water at their easterly ends from the mains of the city of Cleveland. These mains do not deliver sufficient water



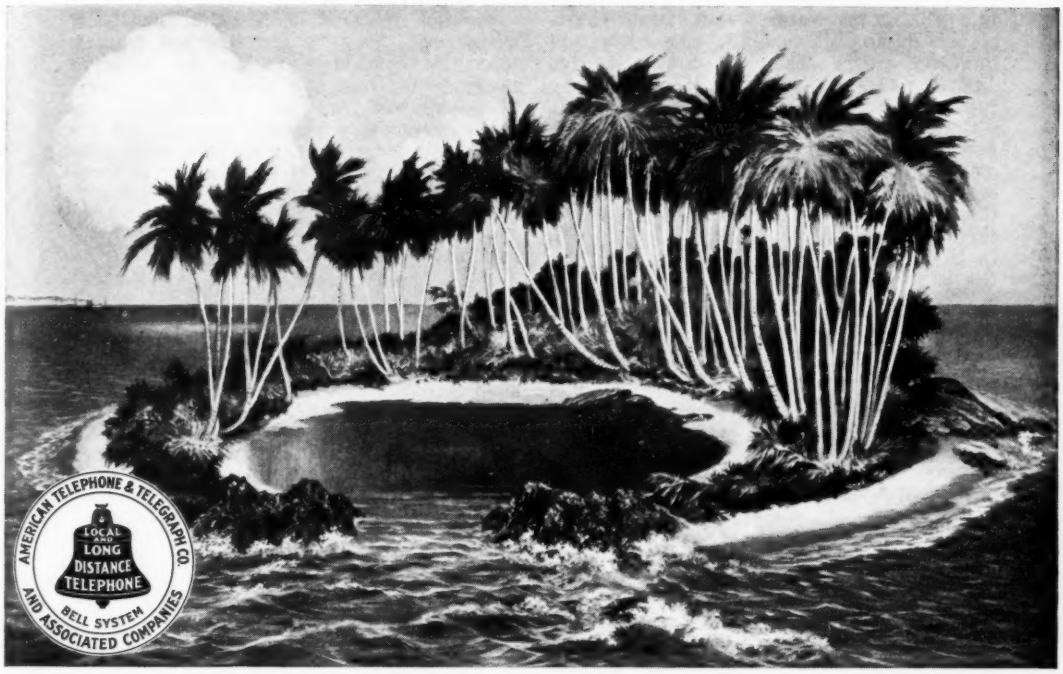
LAKEVIEW TOWER *under construction.*

during the day to supply the district referred to, which contains a population of approximately 14,000 people. It is estimated that there will be sufficient pressure in the mains to fill this tower between the hours of 8:00 p. m. and 6:00 a. m. The tower will remain full until the heavy demand of the afternoon reduces the pressure in the supply main, when the valves will open and the water will flow from the tower for about five hours, or until the pressure in the supply main increases. The capacity of the tower is about 560,000 gallons. This tower is designed for use in summer only and for this reason no cover or roof has been provided and no provision made to protect the 12-inch supply main from freezing. The contract cost of the completed tower was $11,300. The supply line and valves cost $2,300, making a total cost of $13,600. The tower was erected by the Des Moines Bridge & Iron Company of Pittsburgh and Des Moines, according to plans submitted by said company with their proposal for building same.

The distance from the city limits (West 117th St.) to the water tower location on Warren road is about 8,000 feet. Assuming that we will during the night maintain an average head in our mains at Division pumping station of 200 to 210 feet, we can maintain a night pressure at West 117th street equal to a head above city datum of 195 to 205 feet, or say an average of 200 feet. Judging by our experience in the past it is estimated that the supply in the water tower will be drawn upon from about 3 p. m. to 8 p. m. or for about five hours. Estimating the probable number of consumers to be served from the tower at 8,000 and allowing per capita per day during these five hours, the rate of flow from the tower to the low pressure territory during these five hours would be 83,333, say 84,000 gallons per hour or 1,400 gallons per minute.

The diameter of the tower is 46 feet, therefore the water in the same equals 12,432 gallons for each foot in height, and if water is taken from the same at the rate of 1,400 gallons per minute, the water in the tower would be lowered at the rate of one foot in 8.88 minutes, or about 7 feet per hour. In five hours 33.75 feet of water, equal to 419,580 gallons, would be drawn from the tower, and the quantity would have to be replenished during the night, or say, from 8 p. m. to 6 a. m., ten hours. The head on our mains at the pumps will increase steadily from 8 p. m. to midnight, probably as fast or faster than the water will rise in the tower, so that it will be safe to assume an available head to overcome the friction in the 12-inch main in Detroit avenue equal to the difference between the top of the tower (i. e. 190 feet) and the average head at West 117th street (i. e. 200 feet) equal to ten feet. As the distance from West 117th street to the tower is approximately 8,000 feet, the available friction head per 1,000 feet is 1.25 feet.

A 12-inch main under this condition should deliver 675 gallons per minute, or 40,500 gallons per hour. Assuming that all water used by the consumers during the night is supplied by the other parallel mains and that the full capacity of the 12-inch main in Detroit avenue



Coral Builders and the Bell System

In the depths of tropical seas the coral polyps are at work. They are nourished by the ocean, and they grow and multiply because they cannot help it.

Finally a coral island emerges from the ocean. It collects sand and seeds, until it becomes a fit home for birds, beasts and men.

In the same way the telephone system has grown, gradually at first, but steadily and irresistibly. It could not stop growing. To stop would mean disaster.

The Bell System, starting with a few scattered exchanges, was carried forward by an increasing public demand.

Each new connection disclosed a need for other new connections, and millions of dollars had to be poured into the business to provide the 7,500,000 telephones now connected.

And the end is not yet, for the growth of the Bell System is still irresistible, because the needs of the people will not be satisfied except by universal communication. The system is large because the country is large.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
AND ASSOCIATED COMPANIES

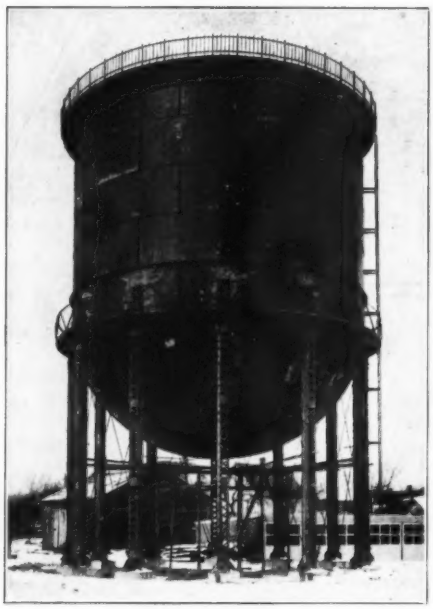
One Policy *One System* *Universal Service*

is available for water tower supply exclusively during the night, the estimated quantity taken from the tower in five hours, namely, 419,580 gallons, can be replenished in about ten hours, or by 6 o'clock a. m. In order to prevent water flowing from the tower before 2 or 3 o'clock p. m., it may be necessary to shut off a valve early in the morning and open the same in the afternoon. Otherwise there might not be sufficient water left in the tower for the heavy usage during the time of sprinkling, which is generally from 4 p. m. to 7 p. m.

The Driving of Rivets

At the time of our going over the original plans and specifications we had considerable controversy and discussion on the subject of driving rivets from the same side of the plate upon which the calking was to be done. The following statements will be of interest to engineers:

Morris Knowles, M. Am. Soc. C. E., civil engineer, Pittsburgh, Pa.—"I should say that the formation of the rivet head



COMPLETED 560,000-*gallon Lakeview water tank.*

should be made upon the side upon which calking is to be done, and as I understand that in the particular instance mentioned the latter is to take place upon the inside, this would mean that the rivets would be put thru from the outside and driven with the head upon the inside."

Samuel E. Duff, consulting engineer, Pittsburgh, Pa.—"I am inclined to say that the ordinary practice is to drive tank rivets from the inside, and I know of no reason why this should not produce satisfactory results. I have no objections to it unless some circumstances were present which I have never encountered in actual work. If the calking is done from the inside I should certainly require the rivets to be headed from the inside, also."

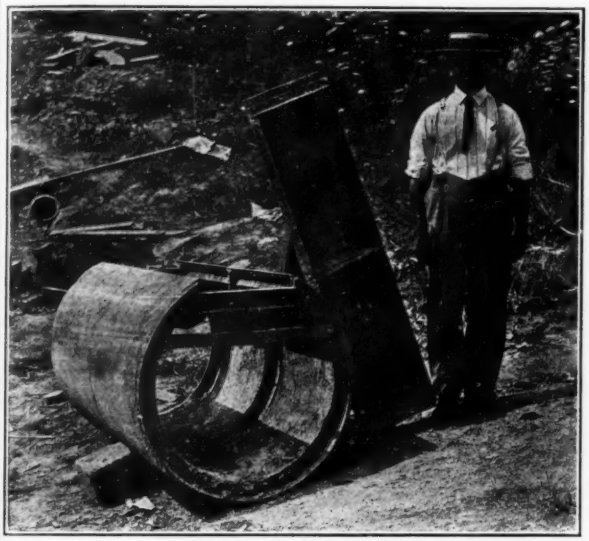
R. E. Brown, Division Engineer, Heyl & Patterson, Pittsburgh, Pa.—"From my experience in field work on some tanks and as shop inspector in a structural shop for a considerable length of time, I would say that it would be almost impossible to get a tight job by attempting to calk the original head of the rivet. By that I mean the head which was formed when the rivet was made and not the head formed when driving the rivet in the field. In order to keep the water from entering the seam, the riveter should be on the inside of the tank, because in that case with careful driving there would be no necessity of calking these heads. This differs from usual boiler practice in that boiler rivets must ordinarily be driven on the outside on account of the restricted space in the boiler, and in that case calking is also done on the outside, probably on account of accessibility and ease of inspection. In this case the water is actually present in the seam and around the rivet, which is a thing to be avoided in tank work if possible."

Wm. C. Coffin, Jones & Laughlin Steel Co., Pittsburgh, Pa.—"In reference to the calking of steel water tanks and the driving of rivets, I would say that I would favor the calking of the tanks on the inside and driving the rivet head on the inside also; that is, putting the rivet thru from the outside. I have been in the business of making water and oil-tight work for twenty-five years, and I do not know of any better procedure in order to get a first-class piece of work."

J. N. Chester, Chester & Fleming, engineers, Pittsburgh, Pa.—"In our specifications for water tanks we have never thought necessary to state that tanks should be calked on the inside but have always presumed on this being common practice, but should we have had occasion to dictate, we under the clause in our specifications which permits us to direct the work would most assuredly have compelled any contractor who sought to do otherwise to do his calking on the inside as well as forming all the rivet heads driven in the field. The rivet heads should be formed on the same side that the calking is done. The calking in all tanks where diameter will permit should be done inside, and it is only

An Improved Method Reduces Costs of Concrete Sewer and Conduit Work.

To Contractors engaged in building concrete sewers and conduits a sure means to gain larger profits is presented in



O'CONNOR
COLLAPSIBLE STEEL
CENTERING

Minimizes labor in placing, adjusting and collapsing other types of forms which are adjusted by threaded devices at either end and in the center. **O'Connor Centering** is made with a removable section of its circumference and is adjusted by means of struts of exact length. There is no opportunity for the diameter of the center to vary at any point.

A slight blow releases the struts, thus reducing the circumference of the form and permitting the ready withdrawal of the removable section.

The O'Connor Collapsible Steel Centering Co.

701 Main Street **HARTFORD, CONN.**

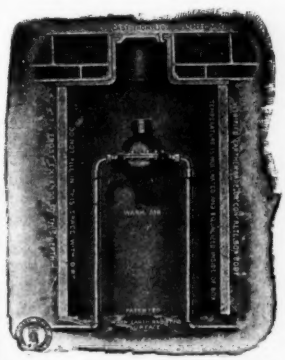
We have yet to receive the first Complaint regarding the lock on a

Clark Meter Box

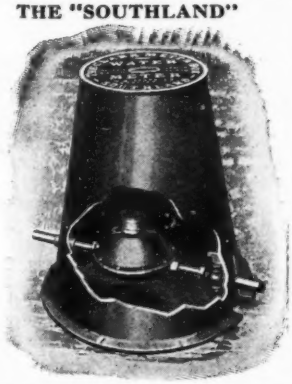
from the thousands of these boxes in use in various parts of the U. S.

And have yet to discover a source of weakness in the principle of this Meter Box. Meter is brought up to a convenient height for reading. No special expensive connections or fittings necessary. No inner lid or covering of felt or other insulating materials used—or needed.

THE "NORTHLAND"



THE "SOUTHLAND"



Vitrified Earthenware or Concrete Box Body extends below frost line. Cover and lid are of heavy cast iron, designed to withstand traffic. Adapted to setting in a concrete walk, asphalt street or similar location. We make special forms and tools that reduce installation **labor to a minimum.**

Low first cost—Thoro protection of meter—Durability with no maintenance. All sizes and types in stock for quick shipment—Send for further particulars and Catalog "M" today.

H. W. CLARK CO.

Manufacturers of Water Meter Boxes for Every Meter—Valve Boxes—Roadway Covers—Collapsible Forms for making Concrete Meter Box Bodies and Tile—Meter Couplings—Gauges—Deep Well Constructions, Pump Plungers, Etc.

1512 Broadway. **MATTOON, ILLINOIS, U.S.A.**

where the space on the inside is insufficient for the hammer men that outside calking and riveting is done under our specifications."

Resurfacing Old Pavements

Court Avenue is but one of the many streets in Memphis which have been resurfaced by this city with sheet asphalt, and the work done has been most satisfactory.

Many of these streets which have been resurfaced were paved with vitrified brick from 12 to 18 years ago. They began to fail seriously of late, and the questions as to what method should be used in repairing them was discussed at length by the Memphis Commission Government. "It was finally determined to use sheet asphalt on top of the old pavement," states one of the engineers. "We first filled holes in the old pavement with concrete. A paint coat was then applied to the hole to afford a contact between the old surface and the new asphalt top which had a thickness of two inches.

"There were altogether approximately 10,000 square yards of pavement laid on Court avenue, Monroe avenue, Union avenue, Gayoso avenue, Center lane and McCall place. The work was done by the Memphis Asphalt & Paving Co., a local firm.

"At the time when this work was done this method was not being very widely used and many inquiries have been received from other cities in the United States as to the success of the method. This class of work has since come to be recognized as one of the standard methods of street construction in handling old pavements thruout the country.

"The Lutz surface heater was used in the above work. This machine is specially adapted for resurfacing old pavements as well as for small patch work on asphalt pavements. For small patch work a 3x5-foot hood is furnished and by adjusting a jet blower that is located above the hood the heat can be drawn to any part of the pavement under the hood, thereby only melting that part of the pavement desired to be patched. About two minutes is required for this operation, another two minutes for the disintegrated parts of the pavement and one or two minutes for moving the heater, consuming about six minutes in the entire operation. Two laborers will consume about twenty minutes or more in chopping out and preparing the same space for patch, and when finished it has the appearance of a garment of many patches. The method of repairing and patching by chopping out the disintegrated parts is not only expensive but unsatisfactory because the hot material does not weld onto the old pavement altho it may be painted with liquid asphalt. There being no union between the old and new material, cracks open up admitting destructive elements, causing decomposition to set in, soon necessitating replacement. With the Lutz heater method the temperature of both materials being at the vulcanizing point, a perfect weld is produced, leaving a finished surface and, instead of it having the appearance of a patch, it becomes a part of the whole and the union between the old and the new pavements cannot be distinguished after one or two days' traffic. The Lutz surface heater is made by the Equitable Asphalt Maintenance Co., Kansas City, Missouri."

Trade Notes

Colonel B. W. Dunn, of New York, chief inspector of the Bureau of Explosives and Combustibles of the American Railway Association, has been elected to membership in the Council of Underwriters' Laboratories. The work in safeguarding life and property which the railway companies have been carrying forward thru Colonel Dunn's bureau is similar in many respects to that undertaken by some departments of the laboratories. The addition of Colonel Dunn to the Laboratories' Council is expected to aid the establishment of uniformity in fire prevention engineering practices.

Messrs. Heap and Digby, engineers, 48 Westminster Palace Gardens, London, England, have been appointed agents and engineers for Underwriters' Laboratories in Great Britain and Ireland. The establishment of a Laboratories' office in England is made in response to recommendations of the British Trade Commissioner in Canada, and in accordance with desires expressed by a number of manufacturers in England who are exporting goods which properly come within the scope of the examination and test work carried on by the Laboratories.

About 100,000 barrels of Universal portland cement will be used on the new Soo terminal in Chicago which extends from 12th to 16th street and is several blocks wide.

The National Incinerator Co., of New York, heretofore building small gas-burning destructors for household and hospital use have taken over the incinerator business of Lewis & Kitchen, of Chicago and Kansas City, and Samuel R.

Are built for economical and reliable service over long periods of time.

Write for Catalogue.

Pittsburgh Meter Co.

Also manufacturers of Cast Iron and Tin Gas Meters; Positive and Proportional Gas Meters for any pressure; and Meter Provers.

General Office and Works: East Pittsburgh, Pa.

The Farmer, you remember, fed his cow sawdust because it was cheap. She liked it fine, but when she was getting used to it *she died.*

Your City Needs GOOD SIGNS More than the cow needs good food.

The best comes from the

INDESTRUCTIBLE SIGN CO.

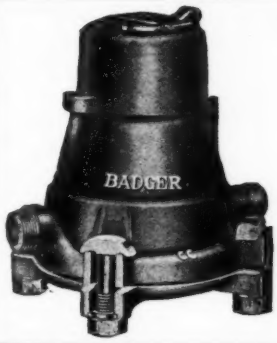
and are made of the best grade of ingot iron—positively rust proof.

No paint to crack or wear off, and will be perfectly legible for a century.

Write us your requirements and we will send sample to cover same.

The Indestructible Sign Co.

528 Dennison Ave. COLUMBUS, OHIO.



BADGER METERS ARE GOOD METERS

—Working parts cannot be damaged by frost or water hammer.

—Repairs can be made right on the spot, thus doing away with all delay, expense and annoyance of returning to factory for dismantling.

—Frost plate has low breaking strength of 600 pounds and can be easily and quickly repaired at a cost not to exceed fifty cents.

The Badger costs less to maintain than any other meter in the world.

Badger Meter Manufacturing Co.

MILWAUKEE, WISCONSIN.

BURDICK PORCELAIN ENAMEL STREET SIGNS ARE USED BY THE LEADING CITIES AND TOWNS OF THE U. S. A. AND CANADA BECAUSE

The Burdick Enamel Sign

is guaranteed not to fade or tarnish from the effects of the weather. They are the only signs in the world which are made of the **very best grade of vitreous porcelain enamel** fused into **high grade English charcoal rolled iron** (No. 18 U. S. Standard Sheet metal Gauge) at 1,600 degrees Farenheit.

THE BURDICK ENAMEL SIGN CO. Chicago, Ill.

Lewis has become consulting engineer of the enlarged company.

Bulletin No. 4 of the Kansas City Testing Laboratory, 1013 Grand avenue, Kansas City, Mo., gives specifications and other information concerning asphalt and other materials used in paving.

H. A. Johnston has taken a position as advertising manager of the S. K. F. Ball Bearing Co., No. 50 Church street, New York City.

The Chicago office of the Ft. Wayne Electric Works of the General Electric Co., have been moved to the tenth floor of the Monadnock building.

The Raymond Concrete Pile Co. have been awarded contract for piling in foundation of power house for Armour & Co., Sioux City, Iowa; train sheds of Union passenger station, Kansas City, Mo.; Gayety theater, New York, and coke plant and stock bins for Maryland Steel Co., Sparrow Point, Ind.

The Solomon-Norcross Co., consulting engineers of Atlanta, Ga., have opened an office in the Randolph building, Memphis, Tenn., which is in charge of H. A. Mentz, Asso. Mem. Am. Inst. El. Engrs.

The MacArthur Concrete Pile and Foundation Co., New York, have contracted for about 150 steel concrete piles in the foundation of the Arcade building at New and Beaver streets, New York; and for the foundation of the Core building of Morgan & Wright Co., Detroit, Mich.

Trade Publications

Water powers constructed or operated by Stone and Webster, Engineering Corporation, Boston, Mass., are illustrated in a handsome booklet with 45 plates.

The Bull Dog Dump Wagon Company, Boston bldg., Kansas City, Mo., and Ft. Smith, Ark., send a circular descriptive of their dump wagons and beds.

Arthur H. Thomas Co., W. Washington square, Philadelphia, Pa., are distributing a list of catalogs, etc., of Carl Zeiss, Jena, Germany, manufacturers of optical instruments.

Catalog 59 of the Kewanee Boiler Co., Kewanee, Ill., describes their water-heating garbage burner.

The Waterloo Cement Machinery Corporation, Waterloo, Iowa, issues a booklet entitled "The Mixers that Make the Money."

Ceresit Waterproofing Co., 446 Commercial National Bank Bldg., Chicago, Ill., issue an international catalog of Ceresit, "The Most Dependable Waterproofing," showing the great extent of its use in foreign countries.

"Tobin Bronze" is the subject of a handsome booklet issued by the American Brass Co., Ansonia, Conn.

Recent bulletins of the Chicago Pneumatic Tool Co. are numbered 128, 132 and 133 and are on pneumatic drills, motors and hoists, and cylinder air hoists, respectively.

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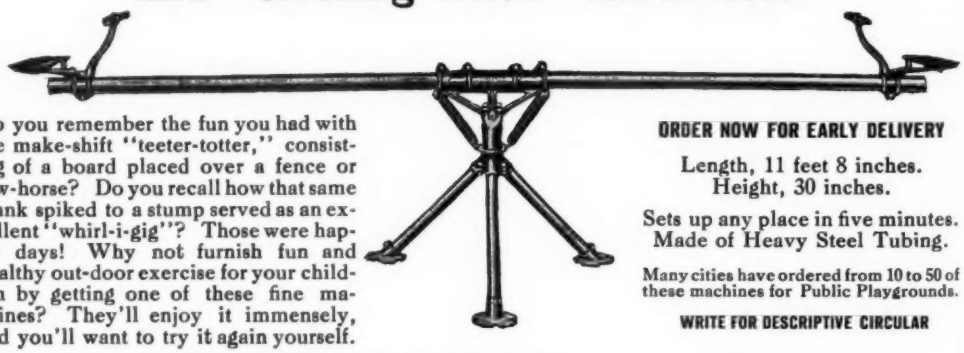

Do you remember the fun you had with the make-shift "teeter-totter," consisting of a board placed over a fence or saw-horse? Do you recall how that same plank spiked to a stump served as an excellent "whirl-i-gig"? Those were happy days! Why not furnish fun and healthy out-door exercise for your children by getting one of these fine machines? They'll enjoy it immensely, and you'll want to try it again yourself.

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